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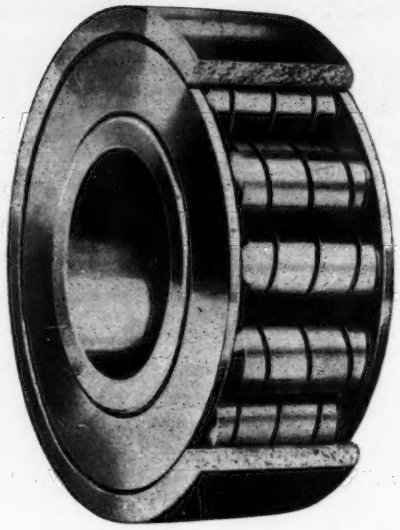

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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, Editor

Vol. 7 JUNE, 1926 No. 6

EDITORIALS

Research in Soil Dynamics

AT A recent meeting of the Royal Society of Arts, Sir E. J. Russell, director of the Rothamsted Experimental Station in England, presented a paper outlining the investigations in agricultural science now in progress at Rothamsted.

Among other things, Director Russell drew attention to the fundamental importance of studies in soil dynamics which apply specifically to the development of cultivating methods and mechanical equipment therefor. Director Russell's comments on this matter are as follows:

"So far we have devoted our attention entirely to the feeding of the crop. There remains the more difficult problem of the cultivation of the soil. Long generations of farmers have evolved a highly efficient art of cultivation, while generations of village smiths, and afterwards their successors, the engineers, have developed tools and implements for doing the work. But the whole thing is empirical; there is as yet no scientific basis for either farmer or engineer to work on; and in consequence there is the risk that the work is not being done as well or as cheaply as it might.

"Cultivation is simply moving the soil, but the result is to collect the fine particles into crumbs, and this not only brings the soil into good condition for root development, but improves the moisture and air relationships of the soil.

"The mechanical part of the process—the moving of the soil—involves three distinct actions: Cutting the soil; sliding the tool over or through the soil; and lifting the soil to turn it over. The processes are all capable of physical investigation. The first step is to measure the total action by a dynamometer recording the drawbar pull between the tractor and the implement. The measurements are complicated by the fact that the soil even in one and the same field is variable, some parts of the field being much more resistant than others. Statistical examination of the data is therefore always necessary. The amount of the pull depends on the constitution of the soil; partly on the visible mineral particles, but mainly on the minutest particles, the clay, which have marked colloidal properties. Colloids are much modified by electrolytes and by other colloids; a striking example is seen in the reduction in drawbar pull brought about by the addition of lime and colloidal organic matter, i.e., decayed farmyard manure or plant residues.

"Extended analyses of the dynamometer records and of the physical properties of the soil are necessary before it is possible to disentangle the parts played by friction, cohesion, plasticity and mechanical work, but the task is capable of precise execution. The further step of discovering how the soil crumbs are formed and how and why their formation should improve the moisture and air relationships of the soil, necessitates studies of surface forces and colloidal properties, which, while lengthy, are within the ambit of a well-equipped physical department.

"One of the first fruits of the physical investigation has been the discovery of a simple means whereby the resistance of the soil to the plow could be reduced. The soil colloids are electronegative; if therefore a negatively charged plate is inserted in the soil the water will pass out from the colloid and become deposited on the plate. Now a film of water is an almost perfect lubricant; if, therefore, the plowshare is kept negatively charged, it becomes coated with a film of water, and therefore continuously lubricated, so that it moves through the soil with less resistance than before. The maintenance of an electric charge is not in principle difficult; it necessitates taking current from the tractor drawing the plow.

"The farmer is not dealing with soil alone, but with soil plus water; the soil remains the same but the water varies considerably from week to week according to the rainfall. All these properties therefore have to be studied in reference to the quantity of water present in the soil.

"The cutting through the soil—in other words, its cohesion—becomes less and less as the water increases; if this were the only factor in cultivation the wetter the soil the better; but the friction on the other hand becomes greater and greater as the water increases; if this were the only factor concerned the drier the soil the better. For each soil there is a certain range of moisture content when cultivation is most easy, neither cohesion nor friction being too great. Further, over this range, variations in moisture content, while they greatly alter the cohesion and the friction, do not appreciably alter the labor of cultivation, the loss on one property being made up by gains on another.

"The end result is not new; good plowmen know it already and have practiced it for generations; they have learned by long experience the happy mean content of water within which the soil can be cultivated and they do not attempt cultivation when the soil is too dry or too wet. But the analysis and explanation of the facts could not before be given.

"This experience happens over and over again whenever an art is being reduced to a science. Harrowing the soil gives a further illustration. Its object is to break the soil lumps to pieces and get them finally down to grains. The scientific worker shows that as a lump of soil dries it shrinks, first by the exact volume of the water lost, afterwards by less than this volume. When the dried soil is rewetted is expands, but it expands more than it shrank. The phenomenon is common among colloids and is called hysteresis; it admits of a simple explanation, because the original wet lump contained no air in its innermost crevices, while the dry soil does contain air; on rewetting, the original air is still imprisoned and helps to expand the lump of soil. It follows that a soil containing a given amount of moisture may occur in two states: the down grade or the up grade, and in the up grade it is expanding more with increasing moisture than in the down grade because of the imprisoned air, and it is therefore more unstable and easily shattered. In order to get the best effect from harrowing, the farmer should allow the soil to dry beyond the point where harrowing would be effective, and should then wait for the rain to rewet the soil up to this point before he harrows. The facts are clearly ascertained and the deduction perfectly sound and of great practical value. But once again the art of the practical man has forestalled the science of the laboratory and the farmer knows this already.

"It might be asked: if the farmer knows these things, and if the effect of scientific workers is but to obscure what seems a simple empirical fact by enshrouding it in involved explanations, why strive to change the ancient and effective art of husbandry into a difficult if not incomprehensible science? The answer is simple: the farmer cannot cultivate without implements; for these he has to go to the engineer. The engineer to have his chance must be given not only a clear cut problem, but also curves and quantitative data of this very kind. In the past he has had to do without this help and make an implement as best he can to the descriptions (you cannot call them 'specifications') of the artist in cultivation. And so it comes about that a great multitude of implements has been laboriously evolved by the costly process of trial and error, whereas with the exact

knowledge of the work to be done they could have been designed for maximum effectiveness.

"We come back, then, to our starting point, that the prime function of an experiment station is to obtain knowledge, precise and well founded, and to express this knowledge in a form in which experts can use it."

These statements bear out quite strongly the efforts which have been made at some of our experiment stations during the past two or three years to develop the underlying principles of soil tillage and to lay down the specifications for implements which will carry out these principles. They show also that England is not far behind us in work of this nature. It is believed that the work along this line should be materially strengthened in this country and should be supported by the farm equipment manufacturing industry.

R. W. TRULLINGER

LETTERS

The Editor welcomes letters from A.S.A.E. members and other readers discussing the contents of AGRICULTURAL ENGINEERING or any question related to the agricultural-engineering field, but he reserves the right to judge as to the suitability of such letters for publication. Neither he nor the Society will undertake to be held accountable for the facts and opinions presented. The Editor also welcomes for publication such correspondence between A.S.A.E. members relative to Society activities and the general development of the agricultural-engineering profession as would be of general interest to the field.

Zinc Coating of Iron and Steel

Raymond Olney, Secretary, A.S.A.E.
St. Joseph, Michigan
Dear Mr. Olney:

I WAS appointed recently by President Wirt to represent the American Society of Agricultural Engineers on the Sectional Committee on Specifications for Zinc Coating of Iron and Steel, sponsored by the American Society for Testing Materials.

This committee has met and the work is under way. The writer attended a committee meeting in New York and was appointed on three subcommittees. In this committee work he wishes to act as truly representative of the Society as possible and hence this letter.

So far there is nothing definite to refer to the Society, but before another annual meeting the work may be beyond the formative stage, and it occurred to me that the coming annual meeting gave an opportunity to ask the membership of the Society, in an informal way, for any suggestions or opinions on zinc coating or galvanizing.

At the risk of becoming tedious it might be stated that the official scope of the project is as follows:

"Development of nationally uniform specifications for the adequate protective coating of different classes of zinc coated products, including outside electrical construction; inside electrical construction, including conduits; sheets and plates and products fabricated therefrom, for outside use; sheets and plates and products fabricated therefrom for inside use; water pipes and associated valves and fittings; agricultural implements, tools and small general hardware; marine hardware and ship fittings; rivets, bolts, nuts, screws and nails; structural shapes; fencing material and woven wire cloth; and including all forms of zinc coating for iron and steel—hot galvanizing, sherardizing, electroplating, spray coating, and methods for the test of all such coatings."

I have been appointed as representative of the A.S.A.E., on the following subcommittees:

Sheets and Sheet Products
Wire and Wire Products
Methods of Testing

I am to serve on these committees under the classification of "consumer."

The writer's personal interest in this matter of galvanized products happens to be in the manufacturing of farm equipment in which galvanized sheets and galvanized wire are used. A part of the membership of the A.S.A.E. are no doubt interested in this same way and I would like to hear from other engineers or manufacturers regarding their requirements for galvanized material.

I have no fear but that I can represent this field adequately but I would particularly like to get in direct touch with the point of view of another class of consumer whom the A.S.A.E. represents—that is, the farmer himself. In the Society the farmer is represented either by membership or through members of faculties of agricultural colleges and universities, engineers of the U. S. Department of Agriculture, etc.

It seems important that the interests of the farmer be taken care of by the A.S.A.E. as directly as possible, and I would like to hear from farmers and farm experts regarding their requirements as consumers of galvanized sheets and wire, and how best to insure proper quality of zinc coating by specifications.

The writer regrets that he is unable to attend the annual meeting of the Society so that he might discuss this matter with some of the members informally. There is nothing for the Society to take formal action on, but I suggest that an informal announcement of this matter be made at the annual meeting to acquaint the membership of the Society with what is under way and to enlist their cooperation in the preparation of specifications for zinc coating.

Possibly the officers of the Society will have some other opinion on this matter and in any way the writer is always at their service.

CHANNING TURNER
Industrial engineer, U. S. Wind Engine and Pump Co.
Batavia, Ill.

(EDITOR'S NOTE: In the foregoing letter Mr. Turner has indicated a desire that A.S.A.E. members offer their suggestions or opinions on this project of developing specifications for zinc coating of iron and steel. Agricultural engineers are very much in sympathy with the elimination-of-waste campaign that has been waged by American Engineering Council, individual engineering societies, and the U. S. Department of Commerce. They realize that there is a tremendous waste on the farm, much of which could be eliminated, and that not the least important of these wastes is that from the rusting of iron and steel. The Society is being given an opportunity to cooperate in the elimination of this waste from rusting through the development of proper zinc coatings for iron and steel. This opportunity carries with it considerable responsibility and members of the Society are urged to respond to Mr. Turner's request for information and suggestions that will be helpful in carrying out this project. You may communicate with Mr. Turner direct or through the secretary of the Society.)

Appreciation

(EDITOR'S NOTE: Before reading the letter that follows, it should be explained to the reader that Prof. Blasingame is agricultural engineering editor of "The National Stockman and Farmer." The fact brought out in Mr. Bayard's letter to the effect that the readers of that publication are manifesting greater interest in its agricultural engineering department is of considerable significance to the members of our profession.)

Prof. R. U. Blasingame
Pennsylvania State College
State College, Penna.
Dear Prof. Blasingame:

I UNDERSTAND that the meeting of the American Society of Agricultural Engineers is to be held in California this year, but I cannot now recall the date. I am wondering whether you are planning to attend this meeting. I hope that you can do so.

I have been very much impressed with the increasing interest in your department in our territory, and I think that the future will see a still greater interest.

One thing I have noted with special interest, and that is the disposition of our readers to give you their experience in agricultural-engineering problems. I sent you two of these articles yesterday, both of which I consider valuable although I do not know how nearly correct the conclusions of the writers may be. Whether their conclusions are correct or otherwise, the fact that farmers write about such things is most encouraging. In the past the farmer's part in agricultural engineering discussions has been that of an inquirer. Now he is taking part in these discussions the same as in other farm problems. I consider this a significant sign of progress.

E. S. BAYARD
Editor, "The National Stockman and Farmer"

Some Results of Tests of the Operation of Combines In Illinois *

By I. P. Blauser

Assoc. Mem. A.S.A.E. Assistant in Farm Mechanics, University of Illinois

THE combined harvester-thresher was first used in Illinois in October, 1924, by Garwood Brothers, Stonington, Illinois, to harvest soy beans. Credit must be given to Garwood Brothers for pioneering the "combine" in the state. After being turned down by two companies they succeeded in getting the third company to sell them a combine to give it a trial in harvesting soy beans which has been the most difficult problem in the growing and handling of that crop.

This first machine was used to harvest two hundred twelve acres of soy beans, sixty acres of which were so weedy that the Garwoods stated they could not have saved them by any other method. Many soy bean growers inspected this machine while in operation and practically all were well pleased with the quality of the work.

By June, 1925, there were seven combines of the same make in Illinois waiting to be given a trial in harvesting small grains. Just one year after the first machine was introduced there were twelve combines in the state. This is truly a remarkable increase, and is due to the highly satisfactory manner in which the combine harvested the soy bean crop.

It is quite commonly agreed by those who have used the combine that it is here to stay if for no other crop than the soy bean; one farmer has said: "We cannot get along without it for harvesting soy beans."

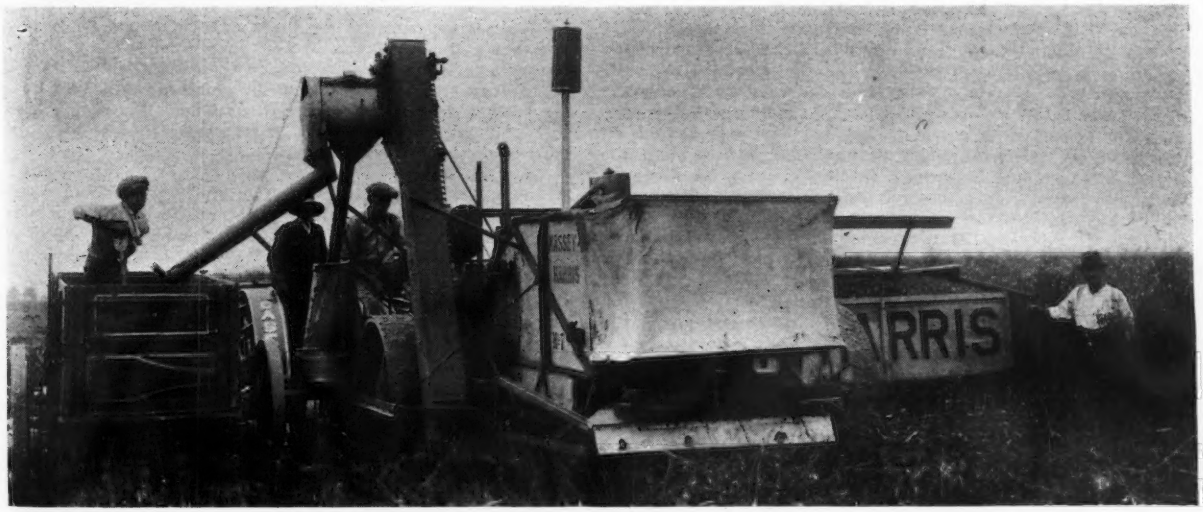
During the past season the combine has been used to harvest wheat, oats, sweet clover, red clover, and timothy, in addition to soy beans. The greater the variety of crops the combine can handle, the greater will be the acreage harvested each season, which, in turn, reduces the overhead costs per acre, making it possible for combines to be used economically on smaller farms. One combine in Champaign County this past season harvested 530 acres, distributed as follows: 230 acres of wheat; 40 acres of oats; 20 acres of red clover; 10 acres of timothy; 10 acres of sweet clover, and 220 acres of soy beans. This acreage was divided between two farmers located eleven miles apart. Other machines in the state have similar records.

The farm mechanics department of the University of Illinois, in connection with its project on grain threshing studies, made a number of tests to determine the total loss in harvesting with the combine. These tests were made in both wheat and soy beans. The equipment used in these tests was the same as that used in testing the efficiency of threshing machines. It consisted of a 16-inch double-cylinder thresher, which was used to rethresh the straw collected from the threshing machine and combine. The small threshing machine was mounted on a two-wheel trailer made of Ford parts and pulled behind a light Ford truck which carried a 4-horsepower Cushman engine to drive the thresher. In making these tests the threshed grain and the straw were collected at the same time, making is possible to determine the percentage of loss. In the case of the combine, a count was made directly back of the cutter bar at the same place the test was made to determine the amount left on the ground. From these two determination of the total loss was calculated. To determine the loss when harvested and threshed by the ordinary method, the threshing machine was tested with the same outfit, and a count made back of the cutter bar of the binder and around the shocks.

The losses behind the cutter bar of the binder and the combine were about the same, averaging about three-fourths bushel per acre for wheat. The loss around the shocks averaged about one bushel per acre. The shock rows in several fields were raked and from three-fourths to one bushel per acre recovered. However, very few farmers follow the practice of raking the field or even the shock rows. The slightly lower loss behind the platform of the combine is to be expected because there is no opening for the shattered material to be lost between the platform and elevator canvasses. The loss around the shock is eliminated entirely by the combine because the material never touches ground. The average loss for the fifty-three threshing machines tested was 1.36 per cent, which brings the total loss of the ordinary method of harvesting and threshing to a little over eight per cent. The average total loss for fourteen tests made with the combine in wheat was a little under six per cent.

In the case of the soy beans, the saving in harvesting with the combine is much greater than by any other method of harvesting and threshing, even though the total loss is considerably higher than the loss in harvesting wheat. The same combine that had been used to harvest wheat, oats,

*Paper presented at the meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1925.



The combined harvester-thresher has invaded the humid regions and has made considerable progress in Illinois

Two views of harvesting soy beans in Illinois in 1925, with a "combine." The mud on the wheels of the tractor at the right shows the very unfavorable conditions under which the beans were harvested last season

sweet clover, red clover and timothy gave an average total loss of 10.62 per cent for fourteen tests in harvesting soy beans. For harvesting soy beans the cylinder speed was reduced, special shoes were put on the cutter bar permitting the machine to cut lower, and the small grain riddles were replaced with soy bean riddles. With this combine, where the beans were standing in good shape, the loss was under 6 per cent and in no test did it go over 17.9 per cent.

Another make of combine was brought into the same section of this state for the first time this year, and was given a trial in harvesting soy beans. It has been used in the western states for small grains, but up to the present time has been used only for soy beans in this state. This combine also is the regular small grain machine, with the cylinder speed reduced and soy bean riddles substituted for the small grain riddles. The first eight tests on this second combine gave an average total loss in soy beans of 26.86 per cent, with the greater part of the loss occurring back of the cutter bar. Changes were made by men from the factory, which permitted the cutter bar to go much lower, and some adjustments were made in the machine itself which resulted in more efficient threshing. After making these adjustments four more tests were made, giving an average total loss of 4.04 per cent.

Both companies are redesigning their cutter bars in order to make it possible for the machines to cut lower than they did this year.

During this past season counts were made back of the cutter bar of the mower, self-rake reaper, and binder in soy beans where the yield was 36.8 bushels per acre, and the losses were 18.2, 14.6, and 25.2 per cent, respectively. These figures represent only the loss back of the cutter bars. A loss of 15 to 20 per cent, which occurred between the machine used in cutting and the threshing machine, and a 1 to 2 per cent loss for the threshing machine itself, must be added to give the total losses for the above methods. Taking the lower figures, the total losses in this particular series of tests are approximately 34, 30, and 41 per cent for the mower, self-rake reaper, and binder respectively. This cannot be compared directly to the work of the combine because the tests were not made in the same field. However, they are not far from the average of a number of similar tests. The two methods have been compared on the same farm, although not during the same year. The combine was working under a big handicap of very wet weather. The loss for the binder was 10.2 per cent while the total loss in harvesting, hauling to the machine, and threshing was 35.89 per cent. On the same farm this year under much less favorable conditions the combine gave a loss of 12.62 per cent. With the special shoes and floating cutter bar the combine gives a loss behind the cutter lower than the binder. The lower cutting of mower and self-rake reaper is offset by the scattered stalks and shattered beans back of the cutter bar.

These tests show that the combine reduces the losses considerably in harvesting and threshing. While definite cost account records are not yet available, it is estimated that the cost of harvesting with the combine is only about one-third that of the ordinary method.

When combines are mentioned, the semi-arid regions of the West are thought of, and they have never been considered practical for the Middle West because of a heavier rainfall. The combine this year proved very satisfactory in small grains and also in soy beans. It might be well to look into the weather conditions and see how this year compared with previous years. The average rainfall for July for the last sixteen years was 2.42 inches, for July 1925 it was 1.14 inches. This would seem that July 1925 was far better than the average. However, the distribution of the rainfall seems to be more important than the amount. On the average the combine can do good work two days after a rain. In July there were two periods, one fourteen days and one three days, without rain, which would give thirteen days to use the combine. The accompanying table shows the total rainfall for July from 1910 to 1925, and also the number of days suitable for using the combine. For the past sixteen years the number of days varies all the way from nine to twenty-one, with an average of fifteen days for July that the combine would give satisfactory results. The largest rainfall in the period from 1910 to 1925 occurred in 1915 when there were 7.3 inches of rainfall; even then there were eleven days during which the combine could work. The smallest amount of rainfall during this sixteen year period was in 1911 when it was 0.62 inches; even then there were only twelve days for harvesting. In 1913 when there were only nine days suitable for using the combine the rainfall was 1.52 inches.

Another question that has caused a great deal of discussion is that of the moisture content of the threshed grain. Numerous samples of wheat were taken from the combine and moisture determination made. These tests ranged from 9.8 to 16.4 per cent, giving an average of about 12 per cent. The samples giving the higher percentages were threshed shortly after showers. The moisture percentage from samples taken from combine and the threshing machine the same day was slightly in favor of the combine. Harvesting wheat with the combine is delayed from seven to ten days after the regular harvesting season.

The fall of 1925 was very wet, rain falling fifteen days in September, twenty-two days in October, and thirteen days in November. This has been a real test of what the combine can be expected to do in a wet season. The combines in central Illinois have each harvested from two hundred to three hundred and fifty acres of soy beans under the most adverse weather conditions. The quality of beans has been exceptionally good. It has been almost impossible to harvest the beans this year by cutting with mower or binder and then threshing, as the bunches and shocks do not dry out sufficiently between

RAINFALL IN INCHES FOR JULY 1910-1925 AND THE NUMBER OF DAYS IN JULY SUITABLE FOR USING THE COMBINE

Year	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925
Inches of Rainfall	2.76	0.62	3.68	1.52	1.44	7.30	0.73	2.73	2.25	2.66	3.19	2.54	2.04	3.26	0.86	1.14
Number of days suitable for Combine	11	12	12	9	18	11	17	16	21	17	13	18	15	17	15	13

showers to thresh properly. With the beans standing in the field, they dry out much more rapidly, and the combine has been starting to work from three to five days sooner than the thresher, and at the same time the beans from the combine show a much lower percentage of moisture. Many fields of beans are still in shock (December 1) with a large percentage of them spoiled. Several combines still have one hundred acres or more of beans to harvest, but the beans are not shattering and from all appearances the quality is not being damaged. On November 4, after five days of fair weather, moisture determination was made of beans threshed by the combine and also by the grain thresher. The combine started to work November 2 and the thresher November 4. The sample from the thresher gave a 24.6 per cent moisture content and the machine was losing fully one fourth of the beans. The sample from the combine gave a 14.5 per cent moisture content, the total loss of the combine being 12.62 per cent.

Just how generally the combine will be used in Illinois remains to be seen. It has established a place for itself with the soy bean grower and has made a good showing in harvesting small grains. Where the farm is not large enough to justify the purchase of a combine, it seems that cooperative ownership by two to four farmers would work out very well. Changes are being made in the platform of the combines, permitting the machine to go through a 10 to 12 foot gate without removing the platform. This will be a great help in moving the machine between fields and also between farms.

Drainage Extension Work in Kentucky

By Earl G. Welch

Assoc. Mem. A.S.A.E. Extension Agricultural Engineer, University of Kentucky

ONE of the big problems in connection with drainage work in Kentucky is that of bringing reclaimed swamp and overflow land into cultivation. A high percentage of this land is covered with scrub timber and needs tile drainage in addition to surface drainage. The owners have paid all or a part of their drainage district assessments and yet have done nothing to increase their income as a result of this investment.

Our plan is to establish tile drainage demonstrations on such land where exact records of expenditure and returns can be secured. The drainage system is planned after the land owner has signed a written agreement to keep the required records. The results secured are given statewide publicity and an increased interest in the work follows. An example of one such demonstration is that conducted on the farm of George Johnson in Muhlenberg County.

Mr. Johnson has seventy-five acres of swampy cut-over bottom land on his farm that produced no income previous to 1925. A dredge ditch furnishes on outlet for tile drainage and removes surface water. The soil is a gray silt loam that is very fertile but for the surplus soil water. A few hundred dollars, sufficient to tile drain ten acres, was available for starting the work. The plan adopted was to clear and drain ten acres and use the income from it to drain additional land.

A survey was made and a drainage system planned for the entire area. A lateral spacing of 75 feet was adopted and an average depth of 2.75 feet for laterals was planned. Since the farm is located in the western Kentucky coal fields, the value of the mine timbers and saw logs secured pays for the cost of clearing the land with exception of removing the stumps.

The cost of the drainage work as reported by Mr. Johnson for the first unit of ten acres, which was installed in the spring of 1925, was $47.52 per acre, distributed as follows:

300 linear feet of 8-inch tile	$ 45.00
5000 linear feet of 4-inch tile	140.00
Hauling tile	60.00
Freight	35.00
Trenching and laying tile	159.00
Backfilling	21.20
Miscellaneous cost	15.00
Total	$475.20

Five acres were planted to corn and five to dark tobacco. The value of the crops produced was as follows:

300 bushels of corn at 80 cents per bushel	$ 240.00
6250 pounds of tobacco at 18 cents per pound	1125.00
Total	$1365.00

According to the department of agricultural economics of the Kentucky college of agriculture, it costs $17.05 an acre to grow an acre of corn yielding 60 bushels per acre, and $105.44 to grow an acre of dark tobacco in western Kentucky. These figures include operating costs, land charges, and the cost of seed. Using these figures, the total value of the crop pays for the drainage work for 1925, the cost of growing the crops, and leaves $277.35 as a net profit.

Mr. Johnson at this writing has his land cleared his tile on hand, and is ready to begin the work of installation of his second ten-acre unit. This kind of demonstration when given proper publicity has a statewide appeal to men who have land that needs drainage.

(EDITOR'S NOTE: The results of such demonstrations by agricultural engineers in extension work are more far-reaching than is usually apparent. The extension engineer is doing a great work in "selling" the farmer on the place of engineering in modern agriculture.)

Report on Windmill Generation of Electricity

THE Institute of Agricultural Engineering of the University of Oxford, of which Capt. B. J. Owen (Mem. A.S.A.E.) is director, has issued Bulletin No. 1, a report on the use of windmills for the generation of electricity. The report is very complete and will be of special interest to agricultural engineers who are working along these lines.

Before and after tile drainage on George Johnson's farm in Muhlenberg County, Kentucky. (Left) The field provided with surface drainage but too wet for cultivation. (Right) The first crop of corn and tobacco paid for the cost of drainage and the cost of growing the crop, and left a net profit of $27.73 per acre

Some Farm Sanitation Problems*

By John R. Haswell

Mem. A.S.A.E. Extension Agricultural Engineer, Pennsylvania State College

BACK when the county agricultural agents were first beginning to wonder "what it was all about" and the farmers' institutes flourished, the teaching staff of the farm machinery department of Pennsylvania State College arranged for county fairs in Pennsylvania an exhibit showing a glass-sided septic tank with a dosing siphon.

Something over five years ago, when the director of agricultural extension was hunting a full-time specialist, the same teaching department, farm machinery, was recommending the use of grease traps along with the dosing siphon to make the septic tank more effective. In taking up the work at the college we found that the farmer was too mystified by the complex layouts and was afraid to send away for a dosing siphon because he did not know if he could install it correctly. The extension division, therefore, changed its first recommendations very quickly and discarded the grease trap, which would seldom be cleaned, and the dosing siphon, which would seldom be used.

The state, according to the last census, is well equipped with running water on the farm, there being at least a supply of cold water in about one-quarter of the farm homes. But often we find water running to the cow stable by gravity or to a trough in the barnyard, while the farmer's wife and children must either pump outside or carry water from a spring some distance away. Our ideal is a system of hot and cold running water in a complete kitchen and bathroom and, of course, the waste water being taken care of in the septic tank. All of our work leads up to this as a goal and we are not doing any extension work in cheaper makeshifts, such as chemical closets.

Quite often there is need for education in the matter of plumbing and we are emphasizing the necessity of at least a 4-inch vent pipe straight out the roof with a cleanout connection at the base of the riser in the soil pipe. Traps are seldom used on the line out to the septic tank but we are recommending the use of deep seal traps from bathtubs.

The state is well supplied with running water from the mountainsides but often this is not high enough to go into the houses, and we are still very friendly to the old hydraulic ram. In other sections the extension of the high-tension service lines by the electric companies and farmer groups has resulted in the installation of electrically driven pumps. Early in 1920 one of the county agents wanted some help with a septic tank for one of his community leaders who was in shape to install it himself. Having become rather skeptical at the various guarantees and descriptions put out by some of the readymade septic tank manufacturers, one of which claims in his guarantee that "there would be no collection of sludge or sediment to be cleaned out," while another states that "no septic tank has ever been designed that will give 100 per cent digestion of solids, statements to the contrary notwithstanding," we looked further.

Having been a close observer of the work of Prof. H. W. Riley and his staff, at Cornell University, we quickly took up the type of septic tank he had been using with the latest modifications to the straight baffles. This tank can easily be built with farm labor from materials usually obtainable at nearby towns. The sizes are enough to hold a 24-hour drainage from the house and they seldom need cleaning more than once in five years. With the better type of farmers there will be no leaking spigots or any great amount of foreign matter thrown into the drains.

The use of 4-inch terra cotta Y branches at the inlet and outlet makes a connection which seals off the house, deflects the sewage down against the baffle without stirring up the sludge, gives a projection beyond the end wall of the tank long enough to connect to the house sewer readily and by the use of the removable plug permits of easy cleaning. Where the tank is close to the house iron soil pipe is sometimes used for the inlet Y branch. At the outlet nothing but water can escape through the bottom branch, while the little vent at the upper side of the straight branch permits the passage of gas.

In order to sell the tank to ourselves and be amply satisfied that we were on the right track, a glass side was placed in a demonstrating model and it was filled with water. By using some colored matter, that is, very fine coal dust, a similarity to a charge of sewage entering the tank could be photographed. The photograph showed the deposition of the heavier particles on the bottom and clear water leaving the outlet. This is primarily research, but the photographs have had a big selling value when shown to farmers.

The bells on the straight parts of the inlet and outlet pipes are closed as shown in the plans, and while this may not in all cases be done by the farmer, if the house system is well vented there will be no trouble, providing the baffle boards are inserted. The passage of the sewage is downward from the inlet under each baffle and after sedimentation the liquid leaves through the downward projection on the outlet.

Early in the work the county agents began to salvage the wooden forms and we have records of some which have built twenty-five tanks. The standard form 6 feet long, 3 feet wide and 4½ feet deep is almost always used. In a small town layout where there are only a few people in the family we are using the next smaller size, while in one county where the number of children usually was eight or more we have a tank form 7 feet long.

In building these forms, as the work progressed the matter of nailing corners caused considerable trouble after the form had been used several times. One of the typical Pennsylvania Dutch farmers, therefore, used three machine bolts on each corner with the heads towards the inside where they could be reached after the concrete was poured and countersunk the nuts on the outside of the form so that they would not turn. Extra strips were added to each corner to strengthen the Cornell type of form and the loose boards around the inlet and outlet pipe were held in place with screen door hooks.

In order to standardize the use of the form as well as the form itself we complied a set of directions which we termed, "The Twelve Successive Steps in Using the Community Septic

A not uncommon scene in rural America which suggests the great need of a sanitation expert. Agricultural engineers have given a great deal of attention to farm sanitation problems, but progress is necessarily slow because the farm population generally does not recognize the great need of proper sanitary measures about the farm

*Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Schenectady, N. Y., December, 1925.

Tank Form." These directions were written after several hundred tanks were built and if followed will prolong the life of the form much better than in one county where the same form has been wrecked twice.

One of the features of our work has been to emphasize the necessity of further treatment of the septic tank effluent and the lawlessness of discharging it into streams or onto the surface of the ground. A recent federal farmers' bulletin calls attention to ninety cases of typhoid fever and seven deaths from septic tank discharge allowed to run over the surface of the ground. Ordinary farm drain tile is used in the absorption lines and at least one hundred feet of tile is recommended for each installation. There are no two lay-outs exactly alike when it comes to absorption tile.

This work has naturally interested school directors and trustees of institutions. Some general plans for one thousand and two thousand gallons per day flow have been developed by the extension division but wherever possible the applicant for assistance is directed to get the services of a consulting engineer.

In order to put this work before farmers, the aid of the county agent is of course absolutely necessary; in fact, in our state the specialist does not go into a county without the county agent being along or at least knowing of his visit.

Rather than offend persons' sensibilities with the grosser side of the subject we have appealed to the farmer's better feelings by showing him of what a comfortable home may consist. This would naturally lead up to septic tanks. In thickly settled sections it is quite a problem to keep the drainage tile away from wells, but the first move should be towards a good water supply before installing modern conveniences. The work of the state department of health in testing water supplies has been of great service in promoting this. One of the beauties of the septic tank is that it is fly-proof if built properly and as flies are large carriers of typhoid fever, this makes a big appeal.

Through the extension service we have the state about 70 per cent supplied with septic tank forms. There are sixty-five available to the farmers, some of which are owned by building supply houses who let them be used rent free when the material is bought from the company. There are now about eight hundred septic tanks in Pennsylvania built after this design and we know of no instances where the twelve steps were followed that the system has failed to give satisfaction.

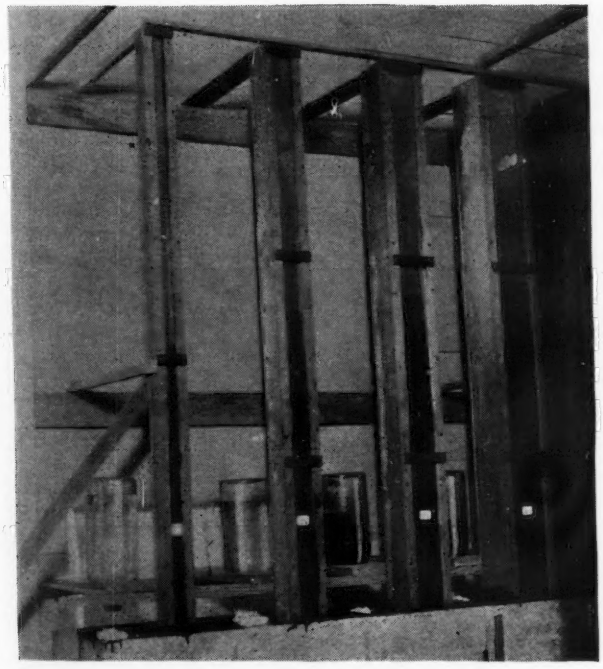
Effect of the Size of Soil Columns on the Capillary Rise of Water

By H. A. Wadsworth

Mem. A.S.A.E. Assistant Irrigation Engineer, University of California

RECENT observations made at the branch of the college of agriculture of the University of California, at Davis, California, upon the rate of capillary rise of water through soil masses of varying cross sections gives considerable evidence that, within certain limits, the capillary rise which may be expected through soil masses becomes greater as the cross section becomes greater.

Square hollow columns of redwood lumber were prepared and fitted with plate glass on one side in order that the ascent of water might be observed by changes of color within the soil mass. The following column sizes were used: 1, 2, 3, 4, 5, 6, 8, and 12-inch. In each case the dimension given is one side of the square cross sections. Each size group was composed of four columns in order that differences caused by irregularities in packing within any individual might be noted.



This picture shows the extent of the rise of capillary water in soil columns after sixteen days. The columns range in size from one square inch to sixteen square inches, reading from left to right

Every care was taken to insure a uniform apparent specific gravity within the soil masses. The weight of soil required for a predetermined volume weight within each column was computed from the volume which was to be filled.

The columns were erected over base pans of galvanized iron which were equipped with simple constant water level devices in order that a fixed water table might be maintained with a minimum of attendance. The water level was held at such an elevation that each column was submerged to a depth of two inches.

Measurements of the rise in each column were made daily during the first month of rise. The decreasing rate of rise after this initial period made less frequent observations acceptable. The observations extended over a period of 263 days. After the first five days of run a rather definite relation became established between the size of the column and the observed rise. For sizes smaller than 25 square inches in cross section, increase in cross section was reflected in a greater rate of rise. For sizes larger than 25 square inches in cross section, increase in area did not result in significant increase in rate of rise. The following schedule shows the average rise of the four individuals within each size group after 263 days observation:

Size of Square Columns (One side in inches, inside)	Rise in Centimeters After 263 Days
1	85.6
2	118.2
3	136.3
4	136.7
5	141.8
6	143.6
8	143.3
12	147.2

The accompanying illustration shows the position of the line separating the moistened soil from the dry in four of the small columns after sixteen days rise.

Intensive soil samples taken from carefully selected points within the soil mass indicate that points in the same horizontal plane carry about the same moisture content. From the results available there is no indication that there is a concentration of moisture within the center of the cross section nor in the zone lying in immediate contact with the walls of the column.

Details of the procedure outlined above and the complete record of the results obtained will appear in an early issue of "Soil Science."

What Simplified Practice Means to Agriculture

By R. M. Hudson

Chief, Division of Simplified Practice, U. S. Department of Commerce

IF THE nation as a whole is to make real progress and if there is to be stability in other industries, then there must be greater stability in agriculture, Secretary Hoover has pointed out on a number of accasions. The problem of securing such stability, he has indicated, resolves itself into a problem of eliminating many of the wastes, by a cooperative effort, spread out over a long period of time, and which enlists the farmer, the agricultural engineer, the educator, and a host of other forces.

The importance of agriculture to the national welfare is based on the fact that almost half of the population derives its living from the production of food and other agricultural materials; that any influence which affects the farmer's standards of living has a direct bearing on commerce and industry; that the needs of the agricultural population supply a huge market for the goods and wares produced by the industrial population; and that the movement of agricultural goods is a primary problem of transportation.

The cooperative effort necessary to eliminate wastes, it has been pointed out, enters into costs of production and marketing, improvement of grades and standards; more careful preparation for market; simplification of the distribution chain; better adaptation of supply and demand; provision of better terminal facilities. In the latter lies a parallel question of freight rates and dockage rates to terminal elevators. These bear on the price the farmer receives.

Elimination of waste is also tied up closely with the things the farmer buys, the price he pays. The wage earner has increased his productivity through improved methods and processes, and through a more efficient utilization of our resources. Increasing his productivity has increased his buying capacity, and in this direction the farmer's interest is a direct one, as a source of supply for his enlarged consumption.

It has been declared by representatives of the U.S.D.A. division of agricultural economics that some of the principal wastes on the farm arise from a lack of uniformity in farm implements; and an improper care of implements and machinery used on the farm. There are others due to the lack of established standards, the existence of unnecessary varieties and dimensions of articles in trade, of a lack of uniformity in many other directions, all of which lead to lost motion, which detract from the productivity of the farmer, reduce his returns and limit his consumption.

The importance of this problem is best recognized by the figures. In 1920 there were 6,448,343 farms in the United States, and 3,925,000 of these are operated by their owners. The 1920 census figures give the value of all farm property in the United States as $77,924,100,338, of which the value of the land was $54,829,563,059, and the value of livestock was $8,013,324,800. The value of the crops, for the year 1924, was $11,404,000,000, and of animal products for the same year was $5,951,000,000, the Department of Agriculture states.

Along with these huge sums, there is a peculiar interest in the growth of the value of farm buildings and of implements and machinery. The 1910 census showed a value on buildings of $6,325,451,528, which had increased in the 1920 census to $11,486,439,543. During the same period the value of implements and machinery had jumped from $1,265,149,783 to $3,594,772,928.

With an equipment of this size, the protection of the farmer's investment in buildings and equipment and the provision for the normal growth and replacement is a matter which reaches into real money.

And this protection becomes doubly a matter of interest when it is recognized that there is a constant growth in the purchase of farm implements. How this growth is tending is indicated by figures from the "Survey of Current Business" for January 1926, which showed that the value of sales of farm implements in the northwestern section of the United States for the period January-October 1925, amounted to $27,187,000, which represented an increase of 47.7 per cent over the sales in a similar period in 1924.

This general-purpose tractor is utilized in all sorts of ways to speed up work and thus save time and labor on the Deems Horseless farm, near West Burlington, Iowa. Here it is shown pulling a manure spreader. With this tractor Roy E. Murphy (Assoc. Mem. A.S.A.E.), manager of the farm, declares the load can be increased 25 per cent and can be distributed in one-third less time than could be done when horses were used

Engineered Transportation

THIS one-ton motor truck is a useful, time-saving vehicle on the Deems horseless farm, near West Burlington, Iowa. It is utilized for all sorts of hauling purposes. The illustration shows how hogs are loaded into the truck. The distance from the farm to the shipping station at Burlington is three and a half miles. Recently twenty head of hogs, gross weight 5850 pounds, were hauled to the station in three trips in two and a half hours. In 1923, the farm records show, it took two round trips and two teams almost an entire day (they started at 8:00 in the morning and finished at 4:30 in the afternoon) to haul twenty-nine hogs, gross weight 7290 pounds, to the same station.

The motor truck is one of the important pieces of farm equipment that is needed to increase farm operating efficiency and to lower production costs. The actual per ton cost of hauling with a motor truck may not in all cases be lower than hauling with horses, but more important still is the fact that it speeds up hauling, enables the farmer to take advantage of better markets, and in large scale production is unquestionably the cheaper means of hauling. In other words, the motor truck is engineered transportation.

This represents one item of many which make up the farmer's expenditures, for he is an increasing purchaser of automobiles, motor trucks and tractors, not only for the efficiency or pleasure of himself and his family, but for the more efficient use of the funds he pays in taxes. Statistics compiled for the National Automobile Chamber of Commerce showed that in 1924 the farm-owned passenger cars numbered 3,453,000 and farm-owned motor trucks 367,900. They also indicated that 19,600 motor busses were being used by rural schools to transport 470,000 children daily to and from schools. The consolidation of rural schools is rapidly gaining ground as a measure of more effective use of taxes. The improvement of highways is an interesting collateral development also.

Returning to the problem of wastes on the farm, there is one development in commerce and industry which should hold a large measure of interest for the farmer, just as it is rapidly gaining interest among the commercial and industrial interests of the country. The need for that development has already been referred to. It arises from the existence of unnecessary varieties and dimensions of articles in common use. The remedy for this is being undertaken collectively by whole industries, with the cooperation of the Department of Commerce, and with the further cooperation of the distributors and consuming groups in those industries. The name of this remedy is "simplified practice."

Simplified practice means the reduction of excess variety by joint action of the producer, the distributor and the consumer. It means the elimination of the obsolete, the seldom-called-for, the articles whose variations are so small as to be meaningless, either from the point of usefulness or value or art.

Simplified practice has a direct interest for the farmer as well as for the manufacturer, the wholesaler, the retailer or the consumer who is a wage-earner. Why? Because it does away with the non-essentials, and permits a concentrated effort on the things that are in active demand. In cutting away of essentials, it is doing for industry what the farmer's pruning knife does for his orchard.

Concentrating the effort of the producer on such essential and live items in his output permits a better use of raw materials. It relieves the producer of the burden of excessive inventories, of the expense of idle machine and operators' time while machinery is being changed to make minor variations. It improves the quality of the product by the improvement of processes and methods, as well as of inspection, and in many cases lowers maintenance costs. "Slack seasons" are reduced, when there is assurance that models will not change often.

For the distributor, it makes possible the carrying of a more complete line of goods with an assurance that the "yearly model" evil will not make a large part of his stocks obsolete. It permits a more active business with smaller capital, lower expenses, better service, and the handling of fresher goods. It also permits a greater care in studying the needs of the consumer and in oredring to meet those needs spreading the orders more evenly and in larger individual quantities.

To the average manufacturer, maintenance and repair is an item of his operating budget which must have serious consideration, whether it concerns his buildings or his mechanical equipment. Should it be less a cause for study by the American farmer with his investment of three and a half billions in machinery and equipment and of nearly eleven and one-half billions in buildings?

There is a field for serious consideration on the part of the farming community of what simplified practice has accomplished in reducing the excess variety in building and construction materials. These include the following:

	Reduced from	To
Metal lath	125	24
Common brick	44	1
Face brick	75	2
Concrete building units	115	24
Roofing slate	98	48
Terne Plate	9	7
Eaves Trough and Conductor Pipe	21	16
Brass lavatory and sink traps	1114	72
Hollow building tile	36	19
Hot Water Storage Tanks	120	14
Range boilers	130	13
Woven wire fencing	552	69
Softwood lumber	Reduced 60 per cent in variety of items, and standards of inspection rules, grading and nomenclature established	
Builders' hardware	Reduced 71 per cent in finishes and 26 per cent in number of items.	

These reductions have had the result of giving the user a broader choice of materials, and a better knowledge of the materials offered for his selection. In his building and repair operations, the farmer's interest in this action surely is just as essential as that of the consumer in the urban territory.

In the maintenance and repair of his equipment the progress of simplified practice has an equal interest, for simplified practice programs have been adopted reducing the number

of plow bolts from 1500 sizes and varieties to 840; forged tools from 665 sizes and varieties of items to 351; milk bottles from 29 sizes to 9; files and rasps from 1351 to 496; while programs have been recommended for the reduction of variety in paints and varnishes; insecticide and fungicide package sizes; and grinding wheels.

In considering what simplified practice holds for the farmer, we must also consider the farmer's partner, his wife. Figures compiled by the Department of Agriculture showed the story for 2,883 farm families of selected localities of the United States for 1922-23. The average purchases, not including what was furnished by the farm itself, totals $870.20. This was spread out over nine items, as follows:

Food	$223.90
Clothing	220.30
Furnishings and equipment	40.90
Operating expenses	209.20
Health	59.10
Advancement, education, etc.	94.40
Personal	36.00
Insurance (Life-health)	35.30
Unclassified	2.50

The tenth item, rent, was represented as 10 per cent of the value of the house.

In these expenditures, much of the responsibility fell on the housewife, for it is she who guides expenditures as to food, much of the clothing, items of operating expenses, health, advancement, and the personal items.

That the women who buy for farm homes are rapidly learning that homemaking is a business which calls for efficiency and orderliness if they are to conserve their energy and their time, is indicated by the reports of the Bureau of Home Economics of the Department of Agriculture, and by farm bureau agents. These reports show that in 292,000 farm homes, the women during 1924 applied themselves to more intelligent purchase, making, and care of the fabrics and textile material used in clothing, linens, wall and floor coverings, furniture and other items. It is a matter of direct information and interest to these women to learn what simplified practice has done in simplifying bed blanket sizes from 78 to 12; in taking steps for the reduction of sheet metal ware which they used in their kitchens by 25 per cent; in doing away with an excessive effort to introduce new patterns in sterling silverware; in taking steps toward the simplification of still other items.

From the Bureau of Home Economics it is also learned that home garden practice was studied during 1924 by more than 91,000 farm women, and that this study also included gardening tools and other equipment, the use of hotbeds and cold frames; that in more than 68,000 homes the women improved the conditions of sanitation. Simplified practice has an interest for these women where the simplification of forged tools included gardening equipment. It has an interest for the members of the family who buy or build hotbeds or cold frames where simplification has touched softwood lumber in the development of American Lumber Standards to help the consumer to make a more effective selection of wood really suited to his needs. It has an interest for those homemakers whose studies of sanitation resulted in installation of modern plumbing, for simplified practice has reduced the variety of brass lavatory and sink traps from 1114 to 72, and is reaching into the field of vitrified enameled plumbing installations, to establish sizes and grades.

Finally, as these simplified practice recommendations are being put into effect, the movement is being studied by many local branches of the Patrons of Husbandry, by the farm bureau federations of various states, and by farm cooperative buying organizations. Some of the Grange organizations have already gone on record urging their membership to buy the simplified goods so far as it is practicable. The farm bureau federations are carrying on a further missionary work, through their local branches, through county agents, and other means.

As the waste elimination movement gains recognition in industry, its progress needs to be spread among the farm population in order that the farmer may make his dollar do its full duty, whether in his equipment and machinery, or in his home. The work has only just begun. "The surface has only just been scratched" say many organizations which have endorsed the movement.

But the fact remains that there is a big opportunity for the farmer to make his wants known. He represents a tremendous purchasing power. He wants to make that power more effective. He can do it by cooperating in waste elimination.

Haying with Engineered Methods and Equipment

IN THE course of an article appearing in "Farm and Fireside" for June, 1926, J. Brownlee Davidson (Charter A.S.A.E.) tell how the labor required in putting up one ton of hay is reduced from more than ten hours, with mediocre equipment, to less than two hours, a saving of more than 80 per cent. Furthermore, and perhaps even more important, the hay put up with the lesser amount of labor has a substantially higher value for feeding or market.

Mr. Davidson advises the use of a mower cutting as wide a swath as is practicable under the circumstances, ranging from five feet for extremely heavy crops and unfavorable topography to eight feet for smooth, level fields and light crops. He mentions also the labor-saving value in field stacking, of sweep rakes and field stackers.

The most important of his recommendations has to do with a method of curing the hay, which he ascribes to J. L. Adams of Wapeelo County, Iowa. It involves the use of a twelve-foot side-delivery rake delivering to the left, so that it may follow the mower in a continuous spiral around the field. The rake should follow the mower immediately, or within a short time, in order that the hay shall be rolled up with the leaves on the inside so as to be protected by the stems on the outside, before drying has occurred to any extent. Thus protected most of the hay, and especially the leaves, is cured by air drying rather than sun drying, preventing the bleaching which impairs quality and leaving the green color which is greatly desired in market hay. By avoiding the too rapid parching of the leaves, not only are they prevented from becoming brittle and shattering off, but they retain for a longer time their function of dissipating moisture by transpiration and thereby expedite the removal of moisture from the stems, the latter being always the slowest to dry out. To promote uniform curing it is advisable to turn the windrows a second time with the side-delivery rake and in case of rainy weather the turning may be repeated several times. The air curing method is advantageous with hay of any kind, but with the various legumes it is imperative if a high grade product is to be secured.

The hay loader effects a saving of approximately fifty per cent in labor as compared to hand loading. For leguminous hays, where shattering of the leaves is a problem, the cylinder type of loader is advised, while for grasses the reciprocating fork type of loader has an advantage in the more effective way in which it forces the hay onto the load.

An uncommonly efficient method of unloading is described. It involves the use of a rack fourteen feet long with basket sides about three feet high. Two slings are arranged crosswise on the empty rack. The load is begun at the rear, building up to full height over the rear sling. Then additional hay is pushed forward and downward, building the remainder of the load on the front sling. This method reduces labor during loading to a minimum, and by hoisting the front sling first insures easy separation of the load. With two horses on the hay rope unloading in this manner can be done in less than ten minutes.

Using a six-foot mower and twelve-foot rake, and counting full time for the boy who drives the rope team, the man labor per acre of hay is as follows: Mowing, 30 minutes; raking, 25 minutes; loading, 30 minutes; hauling, 15 minutes; unloading, 30 minutes. Unusual rates of yield or length of haul will introduce variations in some of the items.

Research in Agricultural Engineering

A department conducted by the Research Committee of the American Society of Agricultural Engineers

A Method of Studying Farm Fires

By E. Grant Lantz

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NECESSITY is the mother of invention and research projects. A farm fire loss of $3,293,863 for the year 1924 was the fact which established the necessity that some attention be given to the causes of Pennsylvania farm fires.

The problem in general was to perform such work as might lead to the reduction of the annual farm fire loss. A questionnaire covering the subject of farm fires was prepared during January, 1925, and circulated in cooperation with the United States Department of Agriculture. The project was general and it followed that the replies returned on the questionnaire were so general as to be of little value in the formulation of definite recommendations.

Generalities had failed to produce results and were promptly discarded. The entire farm fire situation was torn apart and each part analyzed. Curves were prepared to show the number of fires from each cause, and the seasonal characteristics of each cause. From these curves it was not difficult to pick the predominant causes. Lightning and spontanious combustion were prominent.

Precautions Save Lightning Fires. Volumes have been written on the subject of lightning and the devices already created practically eliminate losses from this cause, if they are properly installed and maintained. A fire from this cause can in most cases be charged to carelessness, for it is carelessness not to take precautions which statistics prove advisable.

Fires due to open lights, bonfires, defectve chimneys, defective wiring, static electricity, friction, and smoking are all preventable, and so loss created by fires due to these causes were all classed as carelessness.

Spontaneous combustion presented another angle and the facts as published by the farm press were meager. The farmer had not been fully informed how to prevent fires from this cause, and it was decided to narrow the project to include only this one cause.

Obtain Fundamental Facts. This being the new goal it was necessary to learn fundamental facts—why the hay heats and how it heats. This information was to be obtained from previous publications or from adequate laboratory research. It is obvious that the first method is by far the quickest and least expensive, providing these facts are available. The last resort was the laboratory work and the final portion of the work was the correlation of these facts with farm practice and the development of preventive measures.

The publications of the Swiss Agricultural Experiment Station, at Liebefeld (Berne), afforded authentic fundamentals as to why and how this phenomenon takes place. There was no necessity for any laboratory work at this phase of the project.

Here was a mass of technical facts to be presented to the farmer, if, and only if, Pennsylvania farming practice could produce the conditions which were simulated in the laboratory of the Swiss station. There was no question as to the ability of the chemists to create conditions which caused spontaneous combustion, but were these conditions artificial or were they common to the usual farming practice?

Studying Hay Making Methods. This question led to a detailed study of hay-making methods and storage conditions in those counties which the curves showed to be especially subject to fires from this cause. A questionnaire was designed that would be as simple as possible and yet give the information which was desired. Nearly 400 farms were visited and the opinions of the farmers were noted on the reverse side of the sheet.

From conversation with the farmer it was possible to determine the approximate haying methods and storage conditions for the neighborhood in which he lived, and it often occurred that one was referred to some particular farmer who was considered a community authority on hay making. These men provided a wealth of information, and it was one of these who virtually laid the foundation of the next phase of the project.

Beginning with a report of a case of spontaneous combustion which occurred at The Pennsylvania State College in 1895, a list of six actual cases of spontaneous combustion was built up. In each case the fire was discovered in sufficient time to prevent the destruction of the barn. Notes on these cases were taken not only from the owner, tenant or manager, but from all the neighbors who had assisted in putting out the fire or removing the hay. Here were six results from which the causes could be determined.

Fire a Drain on Nation's Wealth

THE annual loss of $150,000,000 from fires on farms in the United States is a challenge to those who appreciate the importance of the conservation of our resources. The loss is a direct drain on the wealth of the nation, tolerated only because the loss is scattered over so large an area and time that we do not appreciate its enormity. Our country is losing goods that not only have an important money value but that represent years of human labor and a great deal of Nature's goods that are limited in amount and becoming increasingly valuable as the years go by. The fact that a part of the value of property destroyed is covered by insurance does not minimize the significance of the loss, except to the individual owners who have the fires. As a nation we still have to stand the loss. We must recognize that most of the value of property lost in farm fires represent productive goods; property that is being used to increase the wealth of the nation.

—G. I. Christie

Compressed Hay Seat of Heating. In each case the seat of the heating and the subsequent ignition was under or nearly under the point where the hay fork dropped the hay. As the hay was removed a cone of compressed hay was found, indicating that the heat chamber, which the Swiss chemists predicted, had been formed.

The construction of the typical bank barn is such that the hay drops from 20 to 50 feet depending upon the size and design of the barn. The first problem was to eliminate this compressed cone of hay which was in fact a heat chamber.

One farmer was persuaded to roll the hay directly from his wagon over the brest beam into the mow, and it was soon noticed that it was a difficult task to pull the hay apart so that it could be forked about in the mow. The idea of not using the hay fork until necessary was to form a cushion on which the remainder of the hay could be dropped. This method was practically as quick as using the fork and the lower layer of the mow which was usually the most compressed, and the most matted was now loose so that the circulation of air could carry off the heat of sweating as it was formed.

Heat Forms in Balls of Hay. There was an almost universal tendency to roll the large bunches of matted hay which dropped from the hay fork to one side instead of tearing them apart and leveling the mow. Temperature measurements indicated that these balls of hay were in themselves small heat chambers and should be torn apart but their matted condition made the task so difficult that the farmers neglected to do this. The matted condition had to be eliminated before a loose and well-ventilated mow was possible.

Back of the hay fork is the hay loader and this implement was found to discharge an almost continuous matted ribbon on the wagon. It was this matted ribbon which the hay fork was packing into a tangled ball. These ribbons came from the windrows which were the product of the side-delivery rake, an implement almost universally used over the territory under investigation.

The chemists said that moisture, either external or internal, was necessary to produce spontaneous combustion. Investigations of the ocnditions actually showed that even though the upper portion be dry and crisp that the lower side was frequently damp due to being on the ground and not having been exopsed to sufficient sunlight.

Turning the windrow with a hand fork or a tedder two or three hours before loading allowed the hay to be dried more thoroughly, and it was found that this loose hay was easier to load and was delivered by the loader in a looser condition than formerly. A good deal of time could have been saved if the hay had been loaded directly from the swath, but this was not a common practice and labor requirement figures were not determined.

Temperature Is Clue. Clues to the progress of spontaneous combustion are furnished by temperatures and odors. Temperature is the only accurate method of determining the condition of the hay though each heating stage has its own peculiar odor.

To secure the temperature readings a thermometer was inclosed in the pointed end of a long iron pipe which was driven into the mow. The hay was packed so tightly that it was even difficult to take the temperatures by this method.

Leads from an electric thermo-couple were placed at various depths and positions in this mow as it was being filled. The cost of the thermo-couple made its use prohibitive except in unusual cases, but the temperatures taken were used to check a cheaper and more feasible method. A thermometer was placed in a groove cut in one side of a pointed broomstick which could be pushed three or four feet into the mow. The temperature was taken at various points on the top and sides of the mow, but it was determined that the heat rose through the cone of compacted hay and that if the temperature was taken three or four feet below the surface of the mow and directly at the point where the fork dropped the hay that the temperature was rarely ever more than five degrees below the highest temperature registered by the thermo-couple.

Farmers Adopt Practice. A chart was prepared after the notes of the Swiss station so that the farmer could know just what process was taking place at the temperature recorded and what odors were normally present. A number of farmers adopted this scheme and they were intensely interested in the curves, which showed the temperature of their hay during the sweating process.

The project was closed with the publication of a bulletin* on farm fires which included a review of the scientific facts, the proof of the theory, and the remedies to remove the danger of fires from this cause. The publication is admittedly too technical for general distribution to farmers and is being rewritten in a more popular form.

In summary, the methods included a survey of material already available, the study of conditions affecting the project, discovery of a result, the investigation of the causes, and the development of remedies.

*"A Survey of Farm Fires"—Bureau of Fire Protection, The Pennsivania State Police.

This picture is a good example of a successful effort to stop a bad case of gullying. It shows how, as the gully enlarged, it worked toward the highway. The remedy in this case was the use of metal dikes which were spread to catch the washover to a head, which leads to a flume that carries the water over and down

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

The Heating Effect of Radiators, C. W. Brabbee (Journal American Society Heating and Ventilating Engineers, 31 (1925), No. 11, pp. 501-520, figs. 14).—A practical method for testing radiators by comparison is presented in some detail, which is considered not only desirable but essential for correct design and judgment. It is pointed out that a definite amount of heat properly distributed at knee height is required in rooms rather than a certain number of square feet of iron surface. It is concluded that the installation of radiators on the basis of their effective B.t.u. output, as determined by the test method, should result in the most economical and hygiene application of their heating effect.

Artificial Lighting of Poultry Houses, E. T. Brown (Journal Mining Agriculture [Great Britain], 32 (1925), No. 8, pp. 716-720).—Experiments on the effect of lighting poultry houses of the open-front type measuring 24 by 14 feet are reported. The effect of lighting a house was to increase the output of eggs during the winter, although the annual production was only slightly increased. The increase in gross return was more than sufficient to pay for the extra cost of labor and lighting.

Much of the success of the system was found to depend on the brilliancy of the lights employed. Ordinary oil lamps were of very little use, as the birds were not encouraged by the semi-darkness to leave their perches, and there was not sufficient illumination to enable them to find the grains of corn in the floor litter. Gasoline buring lamps fitted with incandescent mantles were found to be excellent. Acetylene was also satisfactory, provided a sufficient number of burners were placed about the shed and efficient reflectors were fitted. The best all around results were obtained with electric light. For the purpose of experiment two 50-candlepower lamps were suspended 5 feet from the floor and two 5-candlepower lamps were used as dimmers. The large lamps were kept burning from 8:30 to 9:55 p.m., when the dimmers were automatically lighted, these being suspended 2.5 feet above the perches. These lights were used for only five minutes each evening to enable the birds to find their roosts after the main lights were switched off.

Dust Explosions in Industrial Plants, H. R. Brown (Industrial and Engineering Chemistry, 17 (1925), No. 9, pp. 902-904, figs. 3).—In a contribution from the U. S. Department of Agriculture Bureau of Chemistry the characteristics of dust explosions in industrial plants are described, and methods for reducing the dust hazard are summarized.

Comparative Tests of Automatic Ventilators, J. P. Calderwood and A. J. Mack (Kansas Engineering Experiment Station Bulletin, 14 (1925), pp. 30, figs. 15).—Comparative tests of thirty representative types of automatic ventilators are reported, the purpose being to determine their relative effectiveness.

The results showed that a slight gain in efficiency is made by those ventilators which utilized wind to better advantage. The rotary siphoning types were the most effective, followed in order by the plain rotary, the stationary siphoning, and the plain stationary types.

Studies to determine the effect which siphons have on the operation of the ventilator showed that three of four ventilators gave better results with all siphons open. All four ventilators gave better results with the siphons closed on the windward side and open on the leeward side. These results are taken to indicate that the siphons slightly assist the effectiveness of the ventilator in some cases.

Slightly better results were also obtained when the siphons on two rotary siphoning ventilators were open than when they were blocked. The increased effectiveness of the rotary siphoning ventilator over the plain rotary type, however, lies chiefly in construction. In the main they were so constructed that the path of egress of air had no obstruction or sharp turns. The projected area was also enlarged, resulting in increased suction. These factors were also used to advantage by the most effective plain rotary ventilator.

The decrease in velocity of moving air due to abrupt turns seemed to be an important factor in automatic ventilators. Ventilators having inlet pipes which projected above the bottom of the storm band were uniformly low in effectiveness. This was especially noticeable in the plain stationary group. It was found that any unnecessary extension of the ventilator pipe above the bottom of the storm band reduced its effectiveness.

The introduction of resistance also decreased the effectiveness of ventilators. A slight decrease in efficiency was noted in those ventilators having an inverted cone or other peculiarly constructed top. Similarly those ventilators which were equipped with shutters decreased in effectiveness in proportion to the obstruction such shutters produced.

The results as a whole are taken to indicate that the most effective action in inducing air through a ventilator is the vaccum produced in the wake of the wind. The most effective ventilators took advantage of this principle. Those ventilators which presented a large obstruction to the wind, other factors being equal, gave the better results.

Foundation Test Loads as Affected by Scale, S. D. Carothers (Engineering and Contracting, Buildings, 64 (1925), No. 4, pp. 939-945).—This is an abstract of a report of studies of the dynamics of soil foundations presented before the International Mathematical Congress at Toronto.

The results showed that the narrower the strip the greater the load which can be carried per foot on any given foundation. If at a certain depth there is a layer of frictionless material, it will be necessary, if the depth is equal to half the width, to limit the load on the surface to a very small amount in order to avoid tension and retain the stress difference within resonable limits.

If test holes indicate that the quality of the soil becomes softer with depth, then the wider the strip the less average load per foot will it carry. If the pressures on horizontal and vertical planes are equal at all points, then all widths of strip should carry the same intensity of loading, provided the soil does not vary with depth. If the pressure on vertical planes is greater than that of horizontal planes, then the maximum stress difference occurs at the edges of the loaded strip and all widths of strip should carry the same intensity of loading, provided the soil does not vary with depth.

[Tests of Equipment for the Production of Potatoes], A. Christensen Et Al. (Statens Redsk. Prver [Denmark] Beret., 37 (1925), pp. 142, figs. 41).—Tests of equipment for the planting, cultivation, digging, sorting, and storage of potatoes are reported in considerable detail.

Present Status of the Facts and Theories of Detonation, G. L. Clark and W. C. Thee (Industrial and Engineering Chemistry, 17 (1925), No. 12, pp. 1219-1226, figs. 2).—In a contribution from the Massachusetts Institute of Technology an attempt is made to collect recent widely scattered and heretofore unrelated experimental chemical, physical, and engineering facts bearing on the general phenomenon of detonation and the factors affecting it in order to examine critically, to suggest further experiments of a fundamental nature, and to make practical applications particularly to the design and operation of internal-combustion engines. The present unsatisfactory status is ascribed to inexactness in the use of terms, to failure to make use of experiments of a purely scientific nature, to many diametrically opposite results by different investigators, to the need of more strictly quantitative data, and to the inherent great complexity of the subject.

Effects of Knock Inducers and Suppressors upon Gaseous Ionization, G. L. Clark, E. W. Brugmann, and W. C. Thee (Industrial and Engineering Chemistry, 17 (1925), No. 12, pp. 1226-1229, figs. 2).—Studies conducted at the Massachusetts Insitute of Technology are reported which indicate that the theory of electron wave fronts in explosions and the absorption of electrons by knock suppressors is not sufficient to explain the practical operation of such chemical substances in the control of detonation in internal-combustion engines. Eight theories of the action of these compounds are critically considered, and new experiments suggested by this work are outlined.

Effects of Various Methods of Applying Fertilizers on Crops and on Certain Soil Conditions, D. G. Coe (Soil Scientist, 21 (1926), No. 1, pp. 7-21).—Studies conducted at Iowa State College on methods and equipment for applying fertilizers on crops are reported.

The results showed that fertilizer applications located in direct contact with seed in the hill or in the drill row are likely to be very injurious to the best germination of the seed. Various factors such as rainfall, soil type, kind of seed, and kind of fertilizer were found to modify the injury produced. Very small amounts of concentrated, readily soluble chemical fertilizers were injurious, and these amounts were often smaller than the rates for which the fertilizer attachments upon available seeding machines could be adjusted.

Small applications of fertilizers produced retarded germination, but large applications caused inhibition of germination, the injury increasing directly with the fertilizer application. It is concluded, therefore, that for the best germination of all seeds under all conditions of climate and soil, the distribution of fertilizers in direct contact with the seed either in the hill or in the row is not advisable, and that planters with fertilizer attachments so designed as to cause such direct contact should be redesigned.

Other methods of localized distribution of fertilizers such as above, below, or at the sides of the hill or drill row were found to be more promising. The above and below locations were found to be inadvisable, however, because of a direct dependence upon climatic conditions and other variable factors. The side method of fertilizer distribution is, therefore, considered to be the best solution of the problem for all crops sown in hills or rows with wide intervals between the successive rows.

Wind Resistance of Motor Vehicles, L. E. Conrad (U. S. Department of Agriculture, Public Roads, 6 (1925), No. 9, pp. 203-206, 212, figs. 6).—The progress results of tests conducted by the engineering experiment station of the Kansas State Agricultural College in cooperation with the Bureau of Public Roads on the resistance of wind at various velocities to a number of standard makes of motor vehicle are reported.

The equations representing the relation between wind resistance and velocity as derived from the experimental data for each car are all of the parabolic form expressed by the type $P=CV^a$, in which P is the wind pressure; V, the wind velocity; C, a coefficient determined experimentally for each car, and a is an exponent also determined experimentally for each car.

The form of the equation is the same for the total and unit resistance, the only difference being in the coefficient, which for the unit resistance is obtained by dividing the coefficient for total resistance by the projected area of the car. The average value of the exponent for the fourteen stock cars tested was found to be 2.14. In no case was the value below 2, and in only one of the equations did it equal 2.

Of the cars tested, a Buick touring car was found to have the highest wind resistance and a Ford roadster the lowest. The resistance of open cars did not appear to be consistently higher than that of closed models. The average equation for the unit resistance of cars tested was found to be $P=0.00149\ V^{2.14}$.

An Automatic and Continuous Recording Balance (the Oden-Keen balance), J. R. H. Coutts, E. M. Crowther, B. A. Keen, and S. Oden (Royal Society [London] Proceedings, Ser. A, 106 (1924), No. A735, pp. 33-51, figs. 11).—In a contribution from the Bothamsted Experimental Station an improved form of automatic self-recording balance is described, in which control is effected electromagnetically. The current passing through a solenoid is automatically adjusted, so that the force of attraction on a magnet suspended from one pan of an analytical balance is just sufficient to keep the balance in equilibrium. The adjustment of this current is effected by the movement of a sliding contact along slide wires, and this movement is in its turn controlled by the slight swing of the pointer attached to the balance beam as the latter moves from its equilibrium position. When the current, and hence the weight on the second pan of the balance, reaches a prearranged value, a subsidiary circuit is automatically closed and a small phosphor bronze ball of known weight is deposited on the pan above the magnet, the sliding contact is brought back to its initial position, and the cycle of operations recommences.

The arrangement of the circuits is such that the distance of the sliding contact from its zero position is to a close approximation linearly related to the current, and hence a recording ammeter is not needed, as a record on a rotating drum of the slider position is sufficient to give the required data. The records consist of a series of stepped curves, and a very open scale is obtained.

The apparatus can be used with no loss of sensitivity up to the maximum load the balance is designed to carry. The sensitivity also can be very simply adjusted, so that both rapid and slow changes of weight can be recorded. The apparatus can be employed with advantage in experiments involving a continuous measurement of increasing or decreasing weight, and its application to the study of sedimentation and flocculation of soil particles and the evaporation of water is illustrated.

Materials Testing: Theory and Practice, I. H. Cowdrey and R. C. Adams (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1925, pp. V+129, figs. [56]).—This book, based on materials testing procedure at the Massachusetts Institute of Technology, contains the following sections: Province of the testing engineer, the report, testing machines, tensile tests, graphs, compressive tests, torsional tests, transverse tests, dynamic tests, test specimens and holders, fractures and their significance, hardness determination, cement testing, testing of sand, timber testing, measuring devices, and verification of testing machines.

Progress Report of Skew Arch Tests, G. W. Davis (U. S. Department of Agriculture, Public Roads, 6 (1925), No. 9, pp. 185-193, 202, figs. 13).—The progress results of studies being conducted by the Bureau of Public Roads on the design of reinforced concrete skew arches are reported.

It has been tentatively established that the vertical reactions vary uniformly from a maximum at the obtuse angle of the arch to a minimum at the acute angle. The increase of the vertical reaction at the obtuse angle of arch varies directly as the angle of skew. The resultant pressures of both the horizontal and vertical components move toward the obtuse angle of the arch with an increase in the skew. The direction of the side thrust is toward the face of the arch at the acute angle, and the intensity increases with the degree of skew.

Lubricants and Lubrication, J. Duguid (Mechanical Engineering [New York], 47 (1925), No. 11, pp. 887-894).—A large amount of data on the subject is presented in condensed form from which specifications for a really efficient lubricant for different types of machinery are derived.

It is concluded that a lubricant must be of sufficient body to keep the bearing surfaces apart at working temperatures, and must possess qualities that will reduce friction to a minimum. It must remain fluid at the lowest temperatures that are encountered under ordinary service conditions, and must meet service requirements as to durability, resistance to elements, usage, etc. It must contain no impurities which will corrode or pit the bearing surfaces, must have no tendency to decompose or form deposits, and must be of sufficient capillarity to feed evenly and successfully, with little change in this respect when encountering natural changes in atmosphere temperatures.

A basis for research in the development of lubricants and lubricating systems for machinery is thus presented.

The Measurement of Humidity in Closed Spaces, J. A. Ewing, R. T. Glazebrook Et Al. ([Great Britain] Department of Science and Industrial Research, Food Investigation Board, Special Report 8 (1925), pp. VI+54, pls. 2, figs. 34).—The results of an investigation into the question of measuring the humidity of the atmosphere in closed spaces are reported, which includes an account of experiments on existing types of hygrometers and a description of novel methods and instruments designed to meet special requirements. These results would seem to have a bearing on studies connected with the development of ventilation and crop storage systems.

Deterioration and Reclamation of Used Automobile Crankcase Oil, A. E. Flowers, F. H. McBerty, and R. Reamer (Industrial and Engineering Chemistry, 17 (1925), No. 5, pp. 481-485, figs. 3).—Information is given on the nature and rate of accumulation of removable impurities in crankcase oil and a method and apparatus for reclaiming used oils are described and the characteristics of the recovered oils are compared with those of new oils. A simple and rapid laboratory method is also described for determining the degree of dilution of the used oil.

Irrigation Requirements of the Arable Lands of the Great Basin, S. Fortier (U. S. Department Agricultural Bulletin 1340 (1925), pp. 56, pl. 1, figs. 14).—Data on the duty of water in the Great Basin collected by the Department during the past twenty-five years are summarized and discussed.

It is stated that the Great Basin comprises an area of 138,789,000 acres, of which 2,313,165 acres were irrigated in 1920. The crops grown included hay, grain, and potatoes at the higher altitudes, and alfalfa, grain, fruit, corn, and canning vegetables on the arable lands at the lower elevations. The seasonal net water requirements of crops under careful use was found to vary from 1.5 to 2.2 acre-feet per acre, depending on the locality.

Alcohol Motor Fuel from Molasses.—II, Use of Alcohol and Alcohol-Ether Mixtures as Motor Fuels, E. C. Freeland and W. G. Harry (Industrial and Engineering Chemistry, 17 (1925), No. 7, pp. 717-720, fig. 1).—In a second contribution to the subject (Agr. Engin.,

This picture shows agricultural engineers testing threshing machines in the shadow of the Washington monument. The picture was taken on the Arlington farm of the U. S. Department of Agriculture

An Advance Scout of Farm Electrification

ELECTRICAL drive for the cream separator deserves special attention by extension workers and other engineers interested in promoting the application of electricity to agriculture. Of all the practicable means of driving the cream separator on the farm, none equals the electric motor in smoothness of torque, a matter of peculiar importance in relation to the wear and tear on the separator gears and bearings. Barring abnormal fluctuations in voltage the electric motor gives speed regulation approaching the ideal, making for uniformity in the test of cream skimmed, and reducing fat lost in the skim milk to the minimum. Its power requirements being low, the cream separator can be driven from the battery of a farm electric plant, thus extending greatly its immediate field of application, and at the same time developing the desire for further electrification. By paying its way the electrified cream separator gives economic justification, at least in part, for the installation of electric service in the farm home, bringing the manifold benefits of electric light and electrically driven household appliances. As engineers we are in danger of devoting our efforts too much to technical matters of productive efficiency, overlooking those greater, though less tangible, human values achieved by abolishing monotonous drudgery and releasing human time and effort for activities of social, cultural and recreational value. Trivial though it may be in terms of watts, the electric separator is of vast significance in taking the curse off a chore that must be done 730 times a year. As such, and as the thin point of an entering wedge in the program of farm electrification, the electrically driven cream separator occupies a strategic place.

vol. 7, p. 25), the methods of securing the best results with alcohol motor fuel under ordinary operating conditions are discussed, and experiments with alcohol and alcohol-ether motor fuels in automobile, tractor, and stationary engines are reported.

It was found that alcohol can be used more successfully in tractors and other engines running at almost constant speeds than in motor car engines. No large admixture of gasoline was necessary for such use. A mixture of alcohol with 0.5 per cent pyridine and one per cent gasoline or kerosene was found to give satisfactory results over considerable periods of time in a number of different types of tractors, motor trucks, and stationary engines. In no case was there corrosion of the engine parts, and in all cases the cylinders were especially free from carbon. When first used in tractors the alcohol fuel consumption was about 50 per cent higher than for gasoline or kerosene, but later this figure was decreased by better manipulation until the excess of alcohol over the other fuels amounted to about 33.3 per cent. A slight advance of the ignition proved advantageous, and no device was used for preheating the air.

Test on the use of alcohol and alcohol denatured with one per cent kerosene and 0.5 per cent pyridine in a kerosene-burning stationary engine demonstrated that equal power output can be secured with internal-combustion engines using alcohol when operating on a constant full load or higher percentage of full load at constant speeds.

The addition of ether to the alcohol was found to improve the fuel considerably for use in automobiles and other engines that operate under variable speed and power conditions. Mixtures of alcohol and ether were found to carburet readily even at low temperatures, and there was no difficulty in starting the engine when cold.

Tests of several mixtures of alcohol and ether to determine the mileages obtained with varying proportions of ether showed a gradual increase in mileage as the proportion of ether was increased. The mileage secured from a given mixture was found to depend largely on the adjustment of the fuel needle valve or the size of jet used. It was found possible to maintain cylinder lubrication when burning alcohol-ether mixtures by adding lubricating oil to the fuel at the rate of about one per cent by volume.

Hydraulics and its Applications, A. H. Gibson (New York: D. Van Nostrand Co., 1925, 3. ed., pp. XV+801, figs. 427).—This is the third edition of this book. It contains sections on physical properties of water—hydrostatics, hydraulics, and hydraulic machinery.

Studies of Curing Concrete in a Semi-Arid Climate, H. F. Conner-man and C. L. McKesson (Lewis Institute, Structural Materials Research Laboratories Bulletin 15 (1925), pp. 37, figs. 13).—Studies on the relative effieciency of various methods of curing concrete in a semi-arid climate are reported. The experiments were conducted on 7-by-10-by-38-inch plain concrete beams made and cured in the open by five different methods. The investigation included transverse tests and tests for surface hardness on five hundred eighteen beams and compression tests on one hundred seventy-five 6-by-12-inch cylinders and prisms. The concrete was machine mixed in the proportion of 1 : 2.2 : 3. Calcium chloride was used as an admixture in 110 beams and 37 cylinders.

A curing method was found to be efficient which maintains the moisture content of the concrete during the early stages of hydration about equal to the original mixing water. Wet earth curing gave the best results of the methods used. This method apparently supplied moisture in sufficient quantity to replace losses due to evaporation and to absorption by the subgrade. Curing methods which permitted high evaporation losses gave concrete of low strength. Concrete cured under earth wet for seven or fourteen days was only slightly stronger than when cured under earth wet for three days. It is concluded that, with temperatures no lower than 70 per cent Fahrenheit, concrete pavements cured by covering with wet burlap for from sixteen to twenty-four hours and then with earth kept wet for seven days, may be safely opened for traffic in fourteen days.

Curing with a surface application of flake calcium chloride at the rate of 2.5 pounds per square yard gave strength ratios of from 88 per cent at seven days to 83 per cent at ninety days. There was a slight reduction in strength when more or less than this amount of calcium chloride was used. The strengths were reduced perceptibly when the calcium cloride was washed off after three hours. Washing off the calcium chloride after one day gave essentially the same strength as when left on the surface. The surface hardness of beams cured with calcium chloride was considerably less than that of beams cured with wet earth or asphaltic paper.

Beams molded and cured in concrete forms using calcium chloride at the rate of 2.5 pounds per square yard showed strength ratios ranging from 100 per cent at fourteen days to 89 per cent at ninety days. The strengths in this case were about 12 per cent higher than those of beams molded in wood forms and cured in the standard manner with a similar amount of calcium chloride. Asphaltic paper curing gave average strength ratios ranging from 92 per cent at seven days to 78 per cent at ninety days, and the surface hardness was almost as high as for wet earth curing. Both air curing and sodium silicate curing produced low strength and surface hardness, the strength ratios ranging from about 77 per cent at seven days to 74 per cent at ninety days.

Two per cent of calcium chloride added to concrete increased the flexural strength about 4 per cent at three days for air and calcium chloride curing and gave no increase for wet earth curing. Calcium chloride, sodium silicate, and air curing produced a more friable surface than wet earth or paper curing.

Studies in the Physical Properties of Soils, II, III, W. B. Haines (Journal of Agricultural Science [England], 15 (1925), No. 4, pp. 529-543, figs. 6).—The second and third contributions to the subject from the Rothamsted Experimental Station are presented. (Agr. Engin., vol. 7, p. 64).

II. A note on the cohesion developed by capillary forces in an ideal soil (529-535).—A calculation is made of the cohesion due to the capillary attraction between the particles of an ideal soil when wetted. Experimental verification of this theory is afforded by cohesion tests on the ignited silt fraction separated from soil. The measurements of cohesion were made with Atterberg's apparatus, which indicates the force necessary to overcome the cohesion of a block of the material under test by means of the penetration of a steel wedge.

The experimental results were found to agree sufficiently well both quantitatively and qualitatively with the theoretical deduction. The only failure was for small moisture values, where the experimental results did not indicate any rise in cohesion. The most important general inference made was that the attainment of high values of capillary cohesion as in soil depends on a small value for the size of the particles. For any given particle size the cohesion has the same order of magnitude at all moisture contents. The predominating influence is the soil texture, that is, it is the number of water films present which matters rather than their radius of curvature as such.

The conclusion is drawn that the value of the internal friction of a soil falls with increasing fineness of the particles. The effect would appear to be strictly analogous to the decrease in friction between two surfaces when the rugosities on them are decreased in size by polishing.

III. Observations on the electrical conductivity of soils (pp. 536-543).—An improved and simplified laboratory method of measuring the electrical conductivity of soils is described, and measurements are recorded for different soil samples.

The results for ignited soil lead to certain confirmations of the capillary theory of an ideal soil. The results for soils generally indicate a sufficiently simple connection between conductivity and moisture for this property to be made the basis of soil moisture determinations. Certain clays were found to form a class apart, and must be regarded as exceptions to the general statement above, owing to the more complex nature of the moisture-conductivity relationship.

Cohesion on Colloidal Soils, F. Hardy (Journal Agricultural Science [England], 15 (1925), No. 4, pp. 420-423).—Studies conducted at the Imperial College of Tropical Agriculture, Trinidad, are reported in which were measured the resistances to transverse breaking, crushing, and parting under tensile pull of standard blocks of soil prepared in different ways and under particular moisture conditions. The soils tested comprised three highly colloidal siliceous soils containing amounts of calcium carbonate ranging from 7.2 and 0.2 per cent and two red lateritic soils.

The most significant results were obtained by employing, in a special tenacity apparatus, granular test blocks, prepared by moistening sieve-graded dry soil packed into restangular molds. The results thus obtained are believed to furnish a reliable measure of the cohesiveness of soil colloidal matter, especially in soil blocks that have previously been brought to a constant moisture content in a humidifier. The method of preparation simulated the effect of rain in causing the running together of colloidal soil particles.

The relative cohesiveness of the soils appeared to follow the same order as their rates of settling from aqueous suspension. This observation is considered to strengthen the view that cohesiveness in colloidal soils is to a certain extent due to chemical forces that depend on the presence of active atoms or atomic groups possessing powerful fields of residual affinity, although film tension probably also plays a part.

Percolation in Colloidal Soils, Considered in Relation to Swelling and Cohesiveness, F. Hardy (Journal Agricultural Science [England], 15 (1925), No. 4, pp. 434-443).—Studies conducted at the Imperial College of Tropical Agriculture, Trinidad, on the rate of horizontal flow and on the rate of gain in mass for both kerosene and water in fine and crumb fractions of three siliceous soils containing different amounts of calcium carbonate and in two lateritic soils, are reported. The methods of experimentation employed were those elaborated by Green and Ampt, whose equations were found, however, not to fit the values obtained.

The siliceous soils possessed relatively high swelling coefficients, and their component particles when wetted were found to cohere to a greater or lesser extent, depending on the lime content. These properties appeared to account for the relatively low rates of permeability to water in these soils. Lateritic soils, on the other hand, possessed low swelling coefficients and low cohesiveness, and water percolated through them relatively very rapidly.

A Study of Reinforced Concrete Dams, E. G. Harris (Missouri University, School Mines and Metallurgy Bulletin, Technical Service, 8 (1925), No. 3, pp. 56, figs. 18).—A comparative study is presented of trapezoidal gravity, arched, horizontal-beam, and vertical-beam dams, one of the purposes being to present a method of study and design of the fourth type.

With reference to reinforced concrete dams, the conclusion is drawn that for more certainty in consistent application of the laws of mechanics, and thereby opening a way to a considerable saving of material, the "mid third" principle should be abandoned and all dependence for resistance to overturning should be placed in an isolated foundation at the outer toe of the column, buttress, or wall. It is further concluded that with the above modification in practice there remains no sufficient reason for sloping the curtain walls of vertical beam dams nor the arch walls of arched dams. It has been found that a great saving of material can be accomplished by making the curtain walls vertical. Vertical beam action is considered more logical for arched dams than cantilever action.

Laboratory Tests of Fuel Savers for House Heating Boilers, F. G. Hechler (Journal American Heating and Ventilating Engineers, 31 (1925), No. 12, pp. 553-556, figs. 2).—Data from tests made at Pennsylvania State College on the effectiveness of various commercial types of fuel saver for house heating boilers are briefly reported. The conclusion is drawn that the large savings in fuel, labor, etc., sometimes credited to the use of these devices cannot be due to any inherent merit of the devices themselves. In the cases where phenomenom savings have followed the installation of fuel savers, the saving has been found to be due to more careful and intelligent operation of the plant, and particularly to a better understanding of the use of the various dampers.

Press Work in Agricultural Machinery Plants, C. C. Hermann (Machinery, 32 (1925), No. 3, pp. 218-219, figs. 6).—In the third article of this series, the drawing dies employed in producing two sheet steel parts for farm machinery are described and diagramatically illustrated.

Electricity for Indiana Farms, T. E. Hienton (Indiana Station Circular 127 (1925), pp. 15, figs. 15).—A brief description is given of some of the uses of electricity now being made on Indiana farms, and attention is drawn to the experimental program now being undertaken by the Indiana Committee on the Relation of Electricity to Agriculture.

Evaporation in Currents of Air, J. W. Hinchley and G. W. Himus (Institute Chemistry Engineering Transactions, 2 (1924), pp. 57-64, figs. 11).—Studies on the fundamental principles involved in the evaporation of moisture in air currents are reported. The results are presented in graphic form, and should have a bearing on work relating to the dehydration of crops and the loss of water from soils.

Book Review

"Use of Water in Irrigation," by Samuel Fortier, D. Sc. (Hon. Mem. A.S.A.E.) consulting professor of irrigation investigations and practice, University of California, formerly associate chief of division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture, originally appeared in 1914. This book is now in the third edition, which has been thoroughly revised and rewritten from the agricultural viewpoint. The book shows the proper methods to follow, the best structures to erect, and the proper procedure in measurements, delivery, and use of water. It shows also the best methods of irrigating staple crops. During the decade that has elapsed since the first edition of this work was published, the practice of irrigation has been much improved, the farmer's part in the irrigation development better understood and appreciated and the fundamental principles of irrigation farming more fully elucidated. To record these changes aright and to present a summarized form of knowledge that has been gained on different branches of the subject since 1915, it has been necessary to add a number of new articles and to rewrite and enlarge much of what appeared in the earlier edition. The book since its first appearance has always been one of the recognized guides to irrigation practice in this country. The book is one of the McGraw-Hill agricultural engineering series of which the late E. B. McCormick was consulting editor. The book is published by the McGraw-Hill Book Company, 370 Seventh Avenue, New York City, and the price is $3.00.

"A Bibliography on Research" is the title of a publication just issued by the division of engineering and industrial research of the National Research Council and it is bibliography of selected articles from the technical press for 1923, 1924, and 1925. The major subdivisions are classified according to the fields of science, engineering, or related industrial groups. No attempt has been made to include references on specific researches in the industries, as the bibliography is intended to cover only general articles on research. One purpose of this work is to reflect in some measure the importance and value of "applied science" in certain industries.

"Blacksmithing," by R. W. Selvidge and J. M. Allton, professor of industrial education and instructor in forging, respectively, University of Missouri, is the title of the second book in the "Selvidge Series" of instruction manuals. It is a set of instruction sheets in book form for use wherever thorough instruction is desired. It consists of an analysis of the blacksmithing trade into thirty-eight unit operations presented in a direct and concise manner with numerous illustrations; information needed by a beginner concerning solders, fluxes, materials, tools, etc.; standard tables of the trade; and teacher's introduction telling how to use the manual. In addition to its use as a school shop text, the book will be helpful to the blacksmith who wishes to advance in his chosen work. It is published by The Manual Arts Press, Peoria, Illinois. The price of the book is $1.20.

"Handbook of Automotive Standards." For the first time, so far as is known, all the standards of a huge industry have been published in a bound handbook. This is the S.A.E. Handbook for March, 1926, just issued by the Society of Automotive Engineers and now being distributed among its members and others who have use for it from the headquarters of the Society at 29 West 39th St., New York. The handbook, although of pocket size, 7½ by 4½ inches and only ¾ of an inch thick, contains more than 600 pages, in which are printed all of the 500 odd standards and recommended practices approve by the society and revised to date. These include a great number of drawings, tables, charts, and forms and much elucidating text. The contents are divided into sections relating to power plant, lighting, electrical equipment, parts and fittings, iron and steel, non-ferrous metals, non-metallic minerals, transmission, axles and wheels, tires and rims, frames and springs, controls, bodies, tests, nomenclature, general, and standards committee regulations. The book is bound in flexible leather covers, and hereafter revised editions are to be issued semi annually, as the society approves new or revised standards and recommended practices only twice a year. Consequently, each current edition of the handbook will contain all of the latest standards, none of which will be changed for several months. The price of the S.A.E. Handbook is $2.50 to members or $5.00 per copy to non-members of the Society.

News of the Annual Meeting

Tahoe Tavern, Lake Tahoe, California

Meeting Dates, June 23-26, 1926 **Inspection Trips, June 28—July 1, 1926**

The Lower San Joaquin Valley

INSPECTION TRIP NO. 4—JULY 1

ON THE last day of the A.S.A.E. inspection tours, July 1, the party will leave Stockton, drive south through French Camp and Lathrop to Manteca.

Manteca is the headquarters for the South San Joaquin Irrigation District (so named because of its location in San Joaquin County). This district, which contains about 67,000 acres of irrigable land, 51,000 acres of which are under cultivation, was organized in 1909, taking over an old privately owned irrigation system which at the time needed considerable extension and enlargement. Water is obtained by diversion from the Stanislaus River at the Goodwin Dam, which is about 2½ miles above Knights Ferry. Water for both the South San Joaquin and the Oakdale districts is diverted by the same dam.

Goodwin Dam is 78 feet high and is a two-arched concrete dam buttressed against a natural rock near the center of the stream.

The Melones Dam, now under construction, will provide storage water for this district and eliminate to a large degree the past difficulties with a shortage in late season water. The Hilts Sag Flume has just been completed and replaces with concrete an old wooden flume which has given considerable trouble. Pre-cast concrete in the form of slabs and as lumber has been used extensively by this district in the construction of flumes, gates, drops and similar structures.

The distributing system consisting of main canals, submains and laterals is quite complete and water is delivered to each 40-acre tract in the district.

As is true in most irrigation projects, a considerable portion of the South San Joaquin district became waterlogged due to excessive seepage and over irrigation. Several thousand acres at one time had a water table within 2 to 6 feet of the surface. The engineers who later designed the drainage systems estimated that there was an annual accumulation of water in this area of about 18,000 acre-feet.

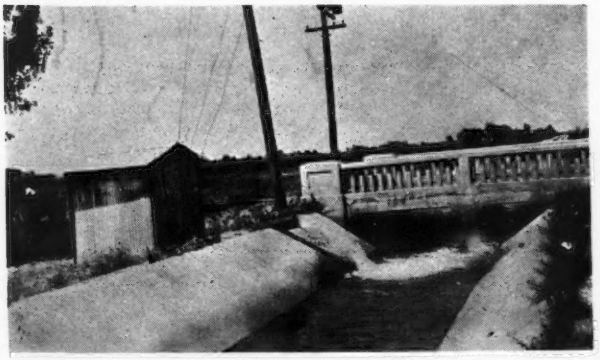
A drainage system consisting of about 90 miles of shallow open ditches was constructed to relieve the situation, but these have not been a marked success. For the most part these drains followed the natural depressions, were too shallow to materially effect the water table and had a rather unsatisfactory outlet into French Camp Slough. Because of the shallow depth and sluggish flow, they soon became foul with cat-tails, tules and other water grasses. More recently, however, the drainage situation has been very materially helped by pumping from deep wells.

From Manteca the route leads southeast along the main line of the Southern Pacific through Ripon and across the Stanislaus River into the Stanislaus County and Modesto Irrigation District. This District, with 60,000 acres under irrigations, was organized in 1887 as one of the first of the Wright Act districts. Here will be found 17,000 acres of deciduous fruits, peaches, apricots and figs, 21,000 acres of alfalfa and dairy ranches, and 13,000 acres of truck such as melons, cantaloupes, sweet potatoes and sweet corn. This district, as well as the Turlock district to the southeast, gets its water supply from the recently completed Don Pedro reservoir on the Tuolumne River. The Modesto District takes its water down the north side of the river, while the Turlock District is on the south side.

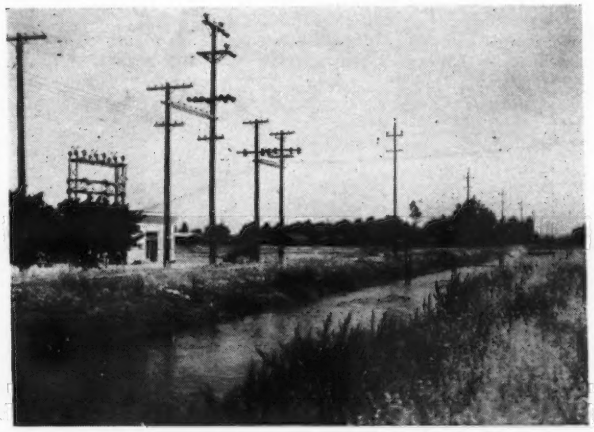
The Don Pedro Dam is one of the notable irrigation structures of the west and consists of a concrete arch 280 feet in height behind which is impounded 290,000 acre-feet of water. After going through the power plant the water is diverted into the main canals of the two districts at the La Grange Dam. This has been the point of diversion of the natural flow since the early history of the districts. Seepage and irrigation losses created a number of areas having a high water table. The usual method of open drainage ditches was tried, but at the present time a number of electrically driven deep well pumps quite similar to those in the South San Joaquin District have been installed.

Just outside the city of Modesto, which is the headquarters for the Modesto Irrigation District, the Tuolumne River separates the Modesto and Turlock Districts.

The Turlock District is the largest of the three to be visited, containing something over 120,000 acres of irrigated land. In this district will be found about 40,000 acres in alfalfa and dairy ranches, about 23,000 acres in deciduous fruits and vines, and about 40,000 acres in truck, of which nearly one-half is in beans, about 6,000 acres in melons and cantaloupes and 15,000 acres in corn. A very widespread and diversified use is made of electricity in both the Turlock and Modesto Districts, not only by the district organizations but by the individual farmers. Probably nowhere else in the



An electrically operated deep well drainage pump in operation on the Modesto irrigation project in California. The pump is housed in a sheet steel house and discharges directly into a concrete-lined irrigation canal



Irrigation is an essential part of the agriculture of the San Joaquin Valley in California. The electrical substation is a distributing point of one of the by-products in irrigation development

This sketch shows the relative location of the several irrigation districts in the lower end of the San Joaquin Valley, California

United States do the farmers have more electrically operated appliances than in this section. Power is developed at the Don Pedro Dam and the Turlock District maintains the unique position of not only developing the power but also of distributing its own electrical energy. In many of the farm homes there are the same electrical appliances as are found in the most up-to-date homes in the city. Cooking, sweeping, lighting and sewing are done elctrically inside of the home and such jobs as milking, cream separating, pumping and similar tasks are performed in the same way outside.

The district also uses considerable power for the operation of drainage pumps. Aside from a seventy per cent interest in the Don Pedro Dam, reservoir and power plant, a fifty per cent interest in the La Grange diversion dam and headworks, the Turlock District operates 250 miles of main canals, about 800 miles of laterals, 75 miles of drainage ditches and about 60 drainage pumping plants. Of the main and submain irrigation canals about 50 miles are concrete lined. The district has a bonded indebtedness of about 6½ millions or $37 per acre.

The Delhi State Land Settlement Colony of about 8,600 acres is located in the southern end of the Turlock District in Merced County. This tract contained some land above the gravity supply of the district. For the irrigation of this land water is pumped both from the canal and from wells. The colony has a complete underground pipe system of irrigation, a feature which tends toward economy in the use of water and the elimination of canal seepage losses. In spite of this, however, a few areas having poor drainage developed. This condition is now corrected by drainage pumping plants, which discharge directly into the irrigation pipe lines and the water is used to supplement the normal supply.

There are many more things in this inspection tour which will interest the agricultural engineer than can even be mentioned in an article of this length, but these three districts are typical of the best organized, best managed and best equipped irrigation districts in the state. These districts have the added attraction for those interested in the use of electricity in that electrical energy is extensively used on the farm. Power is developed as a by-product and is distributed both by the district to its own members as in the case of the Turlock, or through the public service companies as in the case of Modesto and South San Joaquin.

(NOTE: In connection with plans for inspection trip No. 4, we are planning an early start from Stockton, via auto stage, through the San Joaquin and Modesto Irrigation districts. The chief purpose of this excursion will be to show irrigation and drainage practices, manufacture of concrete "lumber" and precast structures, and to inspect typical dairies, poultry farms and farm homes that have been electrified.

The routing will take us through a region typical of the valley. One pumping plant of unusual interest will be visited. It is a deep-well type of pump installed for drainage in an area containing several test wells for the purpose of observing the effect of pumping upon the water table.

We expect to be able to witness the application of water by means of an underground concrete pipe system to an olive orchard interplanted with grapes.

In order to illustrate the use of electricity on the farm, we have chosen three places. One stop will be at an electrified dairy which has installed such applications as milking machine, cooling plant, can sterilizer and silo filler, all operated electrically, while the home contains most of the electrical conveniences.

Another stop will be made at a poultry ranch, where the farmer, who has made a success of his business, hatches and broods chicks and lights his laying houses with electricity. University type poultry houses have recently been erected on this farm.

The third stop will be at an electrified farm residence.

Care has been exercised to choose representative farms, and not to pick out what might be considered impractical show places.

We expect to get back to Stockton by five o'clock, which will enable visitors to make railroad and boat connections to San Francisco or other points.—B. D. Moses)

The Overland Trail to Tahoe

THE route to be followed by the special train to the 20th annual meeting of the American Society of Agricultural Engineers at Lake Tahoe, Calif., June 23 to 26, is one of utmost historic interest and scenic beauty. Over the famous smooth double tracks of the Chicago and North Western Rail-

(Left) Crossing Great Salt Lake where the passenger enjoys the novelty of going to sea by rail. (Above) View of San Francisco water front from the bay

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by HILL
(250 Miles)
126.9
Miles Per Hour
1926
(250 Miles)
131.29
Miles Per Hour

1925
by De PAOLO
(500 Miles)
101.13
Miles Per Hour
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(300 Miles)
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Miles Per Hour

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way, it passes through the fertile prairie lands and prosperous industrial communities of Illinois and Iowa to Omaha where the Union Pacific enters upon its journey along the route of the historic Overland Trail.

This remarkable natural highway was originally opened up by intrepid traders and hunters. Then, as now, it was the shortest route across the continent, and was followed by immense herds of buffalo, by Indians, explorers, gold seekers, Normans, until it became in course of time the trade route to the Pacific coast, used by the covered wagon, the ox wagon driven by the profane "bullwacker," the pony express, and the stage, until the Union Pacific was completed in 1869.

Every mile of the way is redolent with romance and bravery of Indian fighting, of daring and achievement, of the lawless day of the saloon, the dance hall, the faro bank and the roulette wheel, when gun play was common and men died with their boots on.

Now the Indian has lost his picturesqueness, the desperado is gone and the Overland Trail has become a steel boulevard on which you ride in comfort and speed, revelling in the magnificent scenery, from the comfort of the observation platform, where once was bitter hardship, peril and strife.

From Omaha the route is constantly climbing to Sherman, Wyoming, 8000 feet, the highest point on the western trip, and then on to Green River where the line passes through the Wasatch Mountains among some of the most impressive and beautiful scenery of the West. Then on into Utah through the marvellously colored and fantastic Echo and Weber canyons to Ogden, Utah.

From Ogden the journey westward is over the American Canyon route of the Southern Pacific lines, and the trip by the Salt Lake cut-off, across the Great Salt Lake is a most novel experience, like going to sea by rail. After the crossing there is a 200-mile run to Reno, Nev., from where the line follows the scenic canyons of the Truckee River to Tahoe Tavern, the scene of the annual meeting.

After the meeting will be a splendid time for those present to take advantage of the opportunity to see the wonders of the West. Greatly reduced summer rates are in force and delightful return trips at reasonable rates are available via Los Angeles, San Francisco, the Pacific Northwest, Alaska or the Canadian Rockies.

Side trips can be made to Yellowstone, Rocky Mountain, Yosemite, Crater Lake, or Mt. Rainier National Parks, and one that should not by any chance be missed, if it is at all possible, is Zion National Park, Cedar Breaks, Bryce Canyon and the North Rim of Grand Canyon in the gorgeous new wonderland of Southern Utah recently made easily accessible to the tourist by the Union Pacific System.

Agricultural Engineering Texts

OF INTEREST to agricultural engineers is the announcement by the McGraw-Hill Book Company, Inc., to the effect that that organization will develop an entirely new series of agricultural engineering books under the general title of "Agricultural Engineering Texts." It will be produced under the consulting editorial direction of Dan Scoates (Mem. A.S.A.E.), professor of agricultural engineering, A & M College of Texas, and will be made up of two groups, one written especially for agricultural students taking work in agricultural engineering and the other for engineering students who are majoring in agricultural engineering.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the May issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Thomas G. Bard, engineer, Berylwood Investment Co., Hueneme, California.

P. H. Gray, rancher, Covina, California.

O. J. Jennings, Albuquerque, New Mexico.

Charles Kurtz, educational director and organizer, I Dorn Sovietor, Moscow, U. S. S. R.

P. E. Price, extension engineer, Oregon Agricultural College, Corvallis, Oregon.

Dale R. Van Horn, Walton, Nebraska.

Transfer of Grade

I. F. Reed, Orchard, Nebraska.

Employment Bulletin

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of Agricultural Engineering. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Nonmembers as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER, married, age 29, 1922 graduate of Iowa State College in agricultural engineering, now assistant engineer in construction department of International Railways of Central America, desires position where permanent residence is possible, preferably experimental or production work, or management of reclamation project or large ranch. Ten years experience in general farming with power equipment, experimental and teaching work, and construction work. Can speak Spanish, also some French and German. MA-130.

AGRICULTURAL ENGINEER, graduate of Cornell University with advanced degree in agricultural engineering, desires position designing and developing farm machinery and equipment, or doing agricultural engineering research. Experienced in the design of several types of machines and of wooden and reinforced concrete structures. Has demonstrated exceptional inventive ability. Several years instructor and assistant professor in agricultural schools and colleges. MA-131

WORKS MANAGER available. Seventeen years experience in the designing and manufacture of tractors, harvesting machines, and earth-working tools. Sales experience in United States, Canada, England, France, and Italy. Write for interview. MA-132.

AGRICULTURAL ENGINEER, graduate of University of Illinois, nine years teaching experience as assistant professor in one of the largest universities of the central west. Eleven years manufacturing experience with one of the large tractor and farm implement builders. Experienced in production, design, and management. Desires position preferably as extension agricultural engineer or experimental or production manager work. MA-133.

Positions Open

SALES ENGINEERS WANTED: One of the largest bearing manufacturers in America can use the services of two good sales engineers. Men with an engineering education and sales experience in farm tractor and implement field are preferred. They should have designing ability so that they can be of service to customers. Those experienced in the farm-implement and tractor design will be shown preference. Write fully giving all data as to experience, education and salary expected.

YOUNG MAN qualified to act as secretary or assistant to sales manager is wanted by a large farm-equipment concern in Illinois. PO-115.

FACTORY SUPERINTENDENT with foundry experience wanted by farmer-equipment manufacturer in Ohio. PO-114.

RESEARCH STUDENT in agricultural engineering wanted. He will receive fifty dollars a month and will be allowed to do half-time graudate work during this time. Half of this time will be taken up with the experiment station projects now under way. A graduate agricultural engineer preferred. Send application to J. C. Wooley, Agricultural Engineering Department, University of Missouri, Columbia.

AGRICULTURAL ENGINEER wanted to take charge of rural electrification project. Position to be filled at once. Send application to J. C. Wooley, Agricultural Engineering Department, University of Missouri, Columbia.

AGRICULTURAL ENGINEER wanted to fill position at Preston, Cuba. Knowledge of Spanish desirable but not absolutely necessary. Farm experience, knowledge of gas and steam engines, and such machinery as ordinarily used on large sized farms is essential. Salary $150.00 to $175.00 per month, according to experience. Single man preferred. PO-116.

WANTED young man, preferably with agricultural college training, to manage small truck farm. Probably some research work. Apply stating age, education, experience, and salary desired. Office personnel division, 260 South Broad Street, Philadelphia, Pennsylvania.